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WEEKLY 17 August 2024

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This week's issue

On the cover

32 Oceans in chaos
How climate change has pushed our seas to the brink of catastrophe

New Scientist
OCEANS IN CHAOS
How climate change has pushed our seas to the brink of catastrophe
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MICROBES IN YOUR MICROWAVE

Vol 263 No 3504
Cover image: Oleg Breslavtsev/ AdobeStock

36 Why being a cynic is bad for your health

40 Will new prostate cancer tests save millions of lives?

14 How quantum telepathy could disrupt the stock market

19 Leech death spiral **15** Zigzags keep buildings cool **18** Microbes in your microwave **10** How humans first reached Australia

36 Features

"Cynicism is like a tourniquet that cuts you off from social connections"

News

9 Mirror thinking
Solution found to the puzzle of life's "handedness"

16 Terraforming Mars
Could we make the Red Planet habitable with iron glitter?

17 Sweetener risk
Evidence mounts that sweetener erythritol raises chance of blood clots

Views

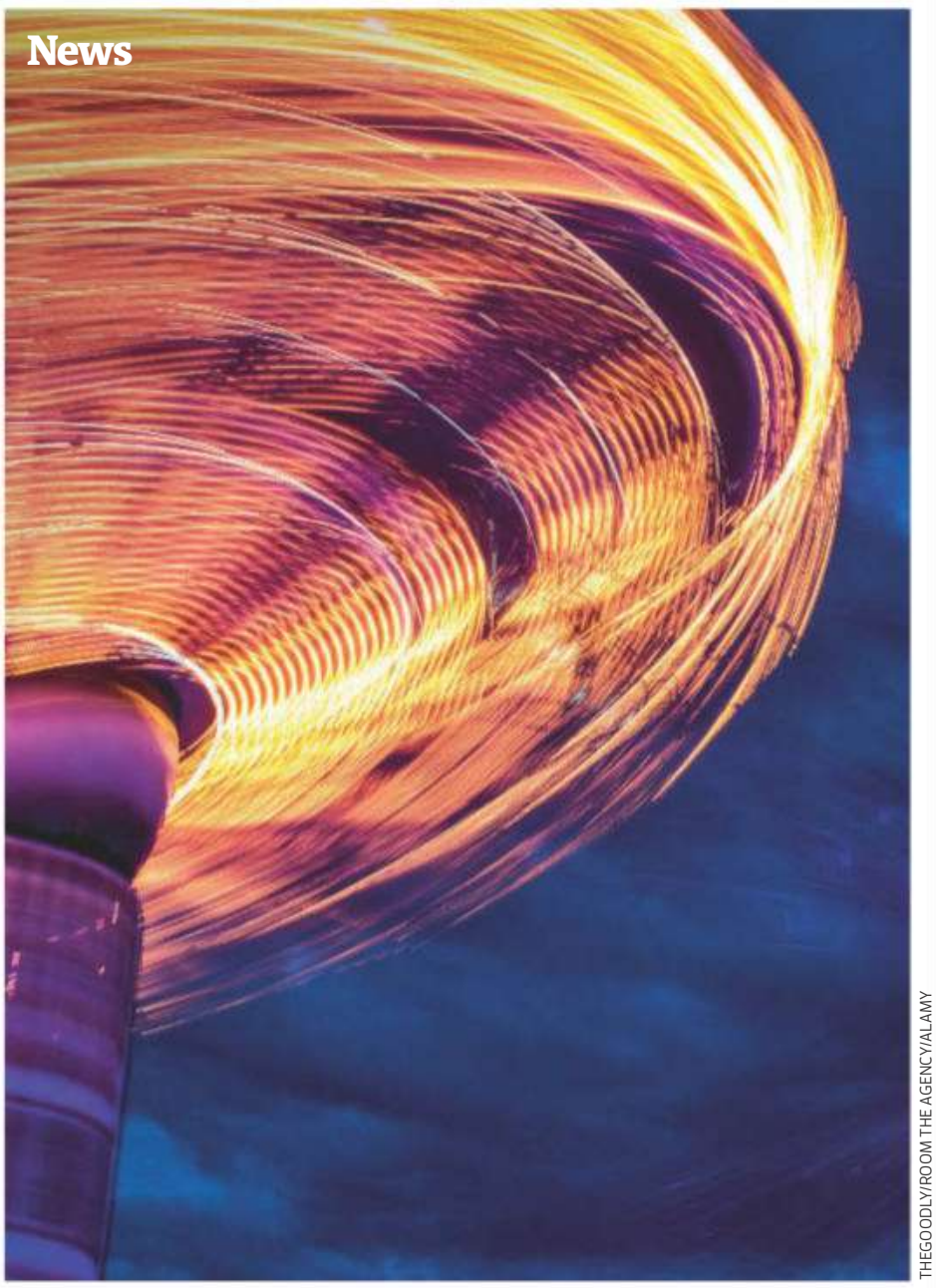
21 Comment
Don't disrespect Alan Turing by reanimating him with AI, says Matthew Sparkes

22 The columnist
Rowan Hooper travels to the 2030s to talk to whales

24 Aperture
Cobalt mines in the DRC

26 Letters
Population isn't really a factor in fairness of sport

28 Culture
A top astrobiologist searches the universe for alien life



THEGOODLY/ROOM THE AGENCY/ALAMY

11 In a spin Quantum theory may force a rethink of a law of momentum

Features

32 Ocean heat
Warming oceans are having disastrous consequences for marine life and humanity

36 The trouble with cynicism
Overcoming your inner cynic could be key to your well-being

40 Prostate time bomb
We are finally getting to grips with how to diagnose this life-threatening condition

The back pages

44 Debunking gardening myths
Do terrariums need charcoal?

45 Puzzles
Try our crossword, quick quiz and logic puzzle

46 *Almost* the last word
What would we see from the edge of the universe?

48 Feedback
Names and faces get the chicken-or-egg treatment

48 Twisteddoodles for *New Scientist*
Picturing the lighter side of life

Elsewhere on New Scientist

NS Live

Universe in verse

Join Joseph Conlon for a unique physics-cum-poetry performance that stretches from the uncertainty principle of quantum mechanics to galaxies and exploding stars. He will tell stories of how things began, where everything came from and the scientists who gifted us this knowledge. See him in action on 13 October at New Scientist Live, either online or in person at London's ExCeL Centre.

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Tour

The geology of the Pyrenees: Spain

Explore the mountain landscapes, geology, culture, food and wine of the Pyrenees with geologist Henry Pettingill. See how the forces generated by the collision of the Iberian and European geological plates created a fascinating mosaic of rocks. This seven-day tour begins on 15 September and costs £4499.

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Podcast

Dead Planets Society

This podcast takes outlandish ideas about how to tinker with the cosmos – from snapping the moon in half to causing a gravitational wave apocalypse – and subjects them to the laws of physics. In the season finale, hosts Chelsea Whyte and Leah Crane go on an epic voyage across the cosmos – taking the entire solar system along for the ride.

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ROD EDWARDS/ALAMY

Smashing rocks Explore the evolution of the Pyrenees mountains

SHUTTERSTOCK/ANDREA IZZOTTI

Underwater vistas Experience the marine world like a sea lion

Video

Eye sea you

Eight Australian sea lions were fitted with cameras and trackers by Nathan Angelakis at the University of Adelaide, Australia. Capturing information from this perspective, with sea lions diving 100 metres underwater and going on six-day-long foraging trips, gives researchers unprecedented insights into their behaviour and their marine habitats.

youtube.com/newscientist

Newsletter

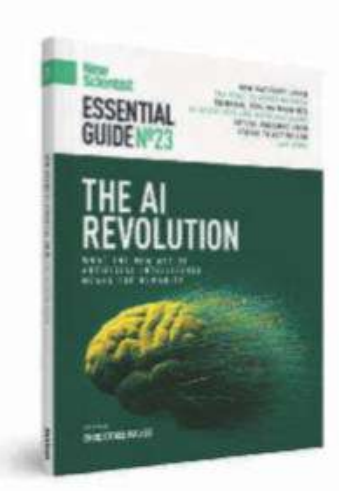
Our Human Story

Altamura man is an incredible specimen known about since 1993, but trapped in Lamalunga cave in Italy. Its secrets remain largely untapped because of its fragility and inaccessibility. Michael Marshall finds out what researchers have gleaned so far and why it is proving so hard to extract.

newscientist.com/our-human-story

Newsletter

"Imagine what we could learn if we got our hands on the whole skeleton"



Essential guide

Tools such as ChatGPT have put artificial intelligence on front pages around the world. So why has AI leapt forwards so suddenly? How can generative AI tools help you? And will this tech lead to human extinction? Get the lowdown on all this and more in our new *Essential Guide*, on sale now.

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Combating food insecurity in a changing climate

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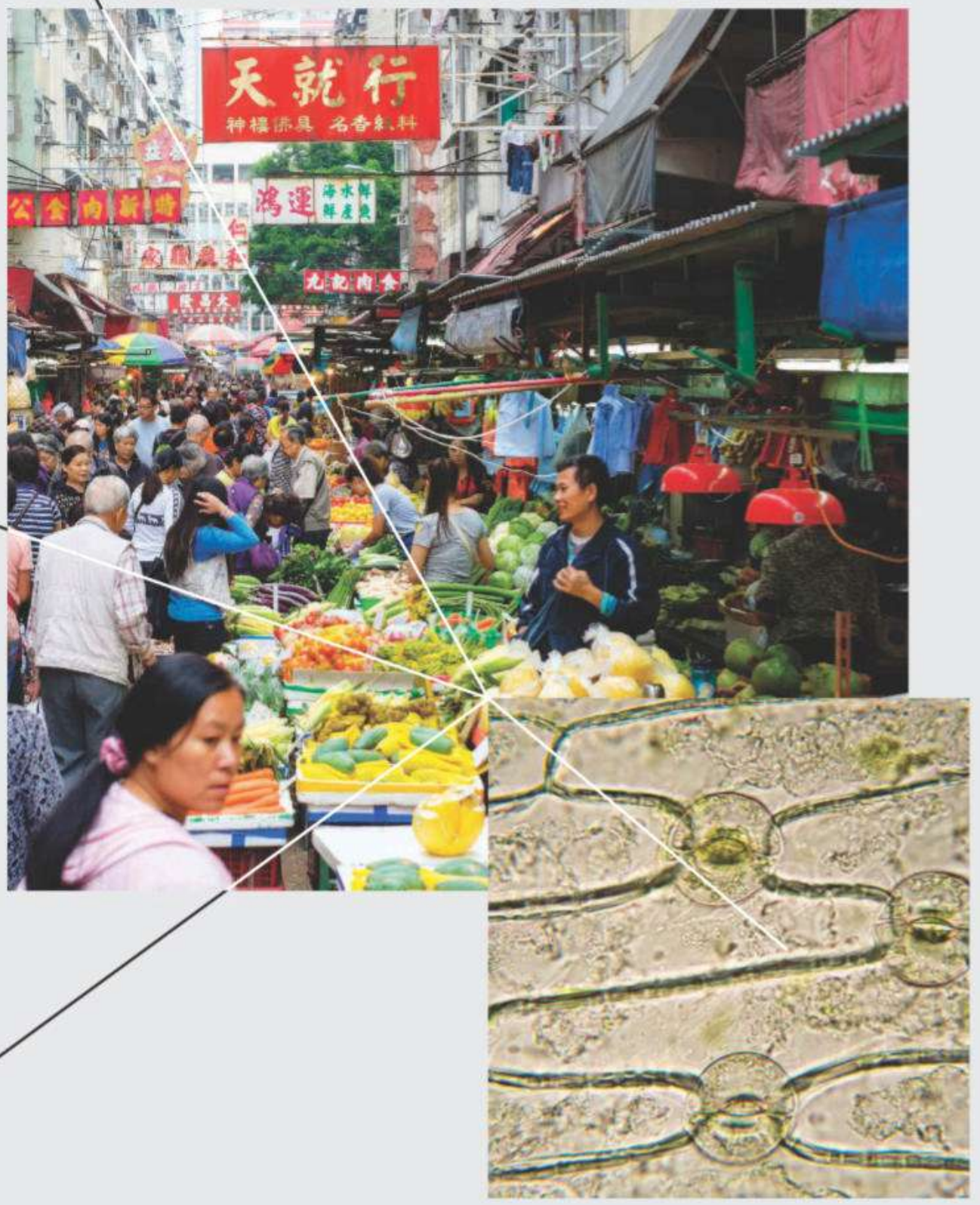

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SCAN ME

In hot water

The crisis in our oceans is exposing just how fast climate change could overwhelm us

OCEAN temperatures have been rising steadily for decades, with our seas having absorbed much of the excess atmospheric heat generated by our relentless burning of fossil fuels. But in March 2023, almost overnight, they suddenly skyrocketed. Temperatures have since remained well above normal, reaching "hot tub" levels in some places, with disturbing consequences that suggest we have pushed ocean ecosystems to breaking point.

As we report on page 32, the rapid rate of these changes and the severity of the havoc they are causing have taken scientists by surprise. But it should also serve as a stark reminder that the impacts of climate change won't necessarily be slow, predictable declines but sudden cascades with grave consequences, many of which we don't fully understand.

Consider the world's coral reefs, which have suffered their fourth global bleaching event on record this year. At a certain point, possibly within a few years, a series of marine heatwaves will probably kill off most of the world's corals. Their demise will spell catastrophe, both for marine life and the people who depend on reefs for food, coastal protection and income.

"The past 18 months show how swiftly systems break down when exposed to new extremes"

Warmer water brings the world closer to other tipping points too. It laps at the edges of melting ice sheets and slows the circulation of ocean currents, for instance. Once these systems collapse, there is no going back.

Yet we fail to heed the warnings. As greenhouse gas emissions creep slowly upwards, it is all too easy to believe the impacts will be similarly gradual. The past 18 months have demonstrated how swiftly systems can break down when exposed to new extremes.

Our response is already long overdue. Cutting greenhouse gas emissions to net zero as quickly as possible is the only way to restore equilibrium in the long term. That will sound familiar. But when you consider the crisis playing out in our oceans, it is hard to imagine more compelling evidence of what we will be facing if we don't take drastic action. ▮

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News

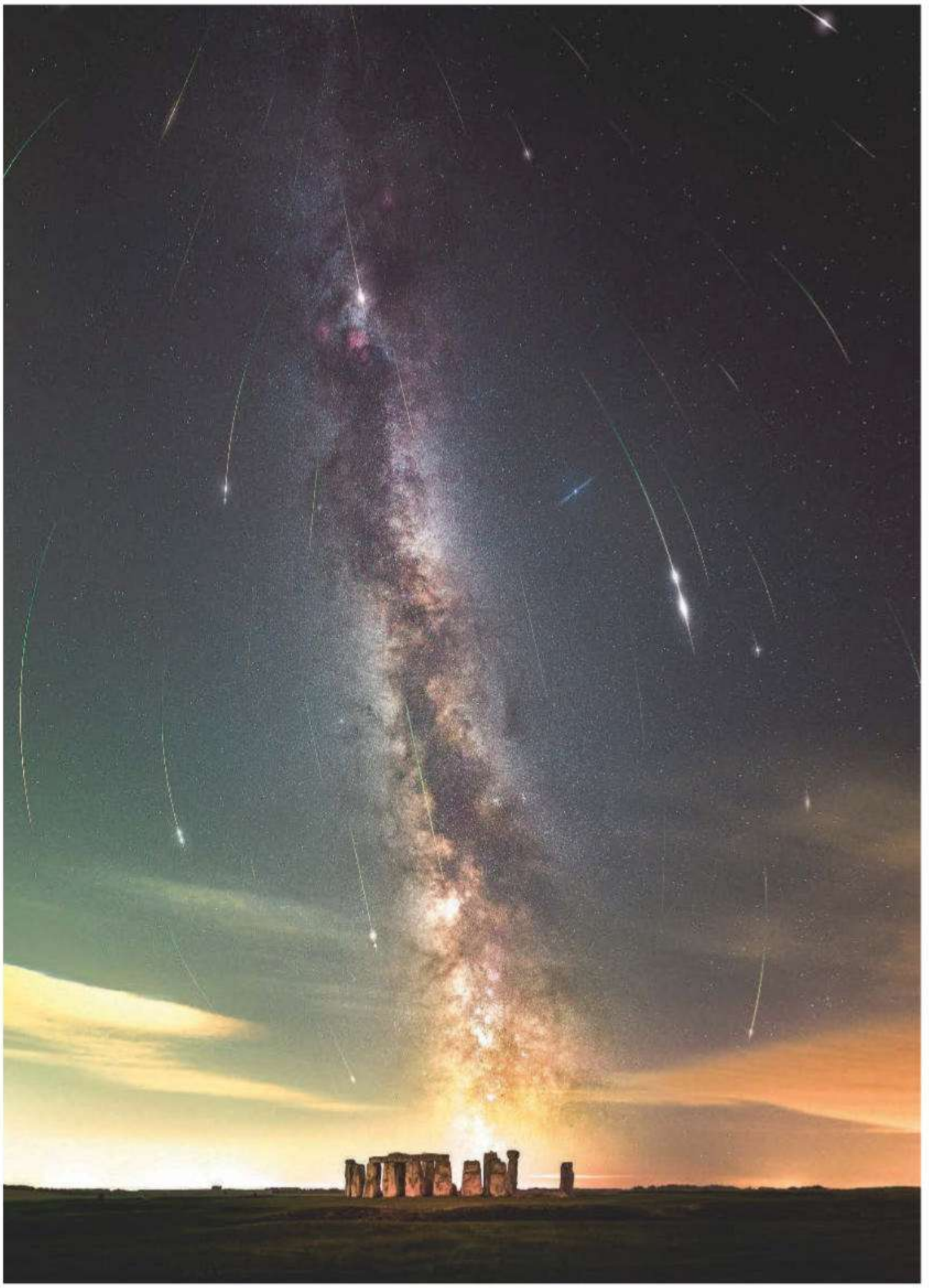
Southern disruption
Antarctica's polar vortex could be about to split in two **p8**

Escape trick
Single genetic change helped covid-19 variant spread **p12**

What lies beneath
Hole drilled a record 1.2 kilometres into Earth's mantle **p13**

Missing people
Satellite data is helping locate covert graves in Mexico **p15**

Privacy issue
Smartphone flaw lets hackers map out your home **p18**



JOSH DURY/SWNS

Astronomy

Meteors light up Stonehenge

The Perseid meteor shower put on an eye-catching show above Stonehenge in Wiltshire, UK, this week. This incredible photo is a composite of 46 images of meteors raining down on the 5000-year-old megalithic monument, taken over 3.5 hours. It also captures the striking and nearly vertical band of the Milky Way shearing through the sky behind Stonehenge.

Environment

Polar vortex on the verge of a split

A disruption of winds in Antarctica could lead to hotter weather in Australia and South America. **James Woodford** and **Madeleine Cuff** report

ANTARCTICA'S polar vortex could be about to split in two for the first time in more than 20 years after a series of sudden spikes in stratospheric temperatures. If that happens, it could lead to significant warming in Antarctica and an unusually hot summer in Australia and South America.

The southern polar vortex is a clockwise swirl of winds that trap a cold air current above Antarctica during the southern hemisphere winter. The vortex is usually very stable at this time of year, with temperatures inside its core in the stratosphere normally being about -80°C (-112°F).

But there are growing signs that this year's vortex is increasingly unstable. In mid-July, wind speeds in the southern polar vortex slowed from 300 to 230 kilometres per hour, allowing cold air to descend and triggering a record spike in stratospheric temperatures. Temperatures inside the vortex were about 20°C (36°F) above the long-term average of about -80°C (see graph, below).

Another slowdown in wind speed was recorded in early August, says Steven Keates at the UK Met Office, the country's national weather service, accompanied by another rapid spike in stratospheric temperatures. "We started to see a marked warming in the very highest layers of the stratosphere," he says.

"If something even slightly unusual happens it can very quickly grow to become an extreme event"

The instability has pushed the vortex out of its place above the South Pole, causing cold polar air at the surface to seep out towards Australia, New Zealand and South America, and warm air to creep over Antarctica, causing a heatwave on the continent.

If the wind slows dramatically, the vortex could rapidly change direction and swirl anticlockwise, in what is known as sudden stratospheric warming. Repeated slowdowns in wind speeds could increase the chances of a vortex split this year, which can be a precursor to sudden stratospheric warming, says Keates.

In 2002, the last time the polar vortex split, there were repeated sharp spikes in temperature and slowdowns in wind speed throughout the winter, before the weakened vortex split in September of that year and collapsed much earlier than usual. It is the only time sudden stratospheric warming has been observed in the southern polar vortex, although other years, including 2019, have come close.

Simon Lee at the University of St Andrews in the UK says even relatively small disruptions to the vortex can have a cumulative effect. "Sometimes minor warmings can set the vortex up for something major later on," he says. "Because Antarctic vortex variability is small, if something even slightly unusual happens it can very quickly grow to become an extreme event."

Sudden stratospheric warming could lead to higher ground-level temperatures in Antarctica, and may trigger hot, dry summers in Australia and South America.

The reason for this is that the weaker winds put an atmospheric system called the southern annular mode into a negative phase, says Martin Jucker at the University of New South Wales in Sydney, Australia. That brings cold polar air over Australia in the winter and hotter, drier air over the country during the summer.

Jucker describes the state of the southern annular mode at the beginning of August as "really extreme". What is happening now with the polar vortex is "definitely a newsworthy event", he says, although wind speeds have returned to near normal in the past few days.

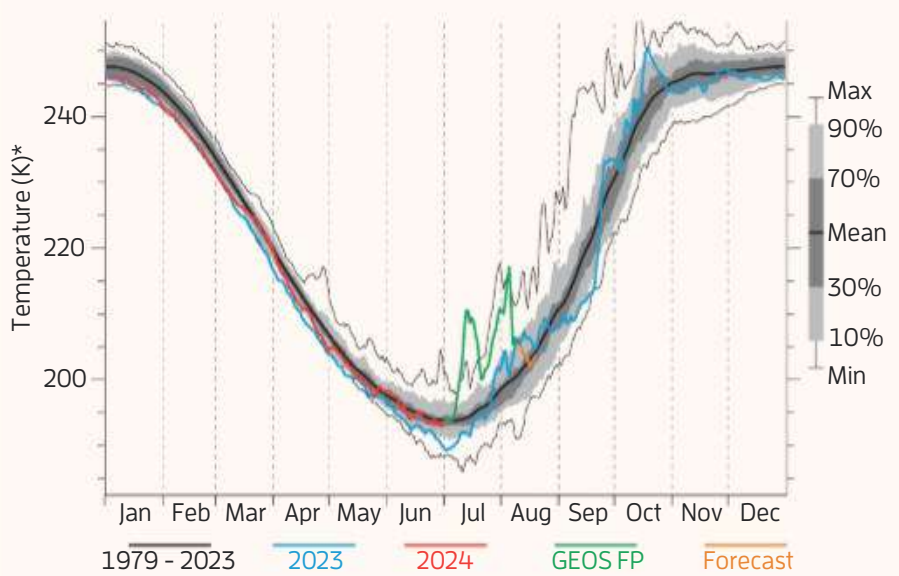
Chantelle Blachut at the University of Adelaide, Australia, studies the southern polar vortex and says this year's structure is very strange, with competing wind patterns warping its shape. "What you can see is this kind of stretching of the polar vortex by two structures either side," she says. "Something unusual is happening this year."

Keates stresses that models are predicting a "huge spread" of potential outcomes for the vortex in the coming weeks. Most model outcomes suggest wind speeds will soon pick up again to above-normal levels, although a minority indicate a further slowdown and, the most extreme model outcomes show a near collapse of wind speeds later this month.

SCIENCE HISTORY IMAGES/ALAMY

Abnormal Antarctica

Sudden surges in the temperature of the southern vortex high in the stratosphere have been seen in recent weeks (green, based on provisional estimates) and are outside the normal range for the time of year (grey shaded area). The spikes were caused by wind speeds dropping and hints the polar vortex is at risk of splitting



*The range of the temperatures shown in kelvin (185-255) equates to -88 to -18°C and -127 to 0°F

SOURCE: P. NEWMAN (NASA), L. LAIT (NASA), S. PAWSON (NASA)

Winds above Antarctica have widespread effects

"It's very uncertain," says Keates.

Emerging research suggests climate impacts could be at least partially to blame for a weakened southern polar vortex. Winds in the stratosphere are slower than normal in years with lower than average levels of Antarctic sea ice, according to a study published last week. Antarctic sea ice cover hit a record low in 2023 and has remained well below the long-term average throughout 2024.

Jucker suggests the massive increase in water blasted into the stratosphere by the eruption of the Hunga Tonga-Hunga Ha'apai volcano in 2022 could also be a contributing factor, as well as record sea temperatures. ▮

See page 32 to find out about how the world's oceans are on the brink

Chemistry

Do we finally understand the mystery of life's 'handedness'?

Michael Le Page

A LONG-STANDING puzzle about what determined the "handedness" of molecules inside living cells may finally have a solution, thanks to a happy accident in the lab.

"We were really surprised when we got this selection that exactly matches up to what life uses," says Thomas Richards at the University of Oxford.

Just as our left and right hands are mirror images of each other that can't be superimposed, many molecules also have left or right-handed forms, a phenomenon known as chirality. Chemical reactions normally produce an equal mix of the two forms, yet in all the living organisms on Earth today, there are distinctive patterns of chirality.

The deoxyribose and ribose sugars in DNA and RNA are always the right-handed forms, for instance, while the amino acids that are strung together to make proteins are always the left-handed forms.

The question is, why? Over the decades, scientists have proposed numerous explanations, many involving exotic physics, but no single idea is widely accepted.

Richards didn't set out to study this mystery. He and his team were just creating "bags" made of cell membranes to do experiments in when they accidentally discovered that the make-up of these membranes could offer an explanation of life's handedness.

It has long been known that small molecules such as sugars and amino acids can pass through cell membranes, but what the team discovered is that there are big differences in how easily these can move through different kinds of membrane. All cell membranes are made of fatty molecules called phospholipids, but those found in bacteria are a bit different to those in archaea, the other main kind of simple cell.

The researchers found that archaeal membranes and a hybrid membrane that consists of a mix of bacterial and archaeal phospholipids are much more permeable to the right-handed form of deoxyribose and ribose than pure bacterial membranes are. The hybrid membrane is also more permeable to the left-handed forms of some amino acids (bioRxiv, doi.org/ncm4).

"These membranes are acting as a sieve that separates out specific forms of molecules"

That means these membranes are acting as a kind of sieve that separates out specific chiral forms of molecules, says Richards. If such membranes existed early in the evolution of life, they might explain why living organisms came to use these particular forms.

Richards says he was excited about this match-up between the permeability characteristics and what the key metabolic systems of life evolved to use. "It's a really neat explanation of why central metabolism evolved to be the way it is."

"This paper reveals a possible prebiotic route to left-handed amino acids and right-handed sugars," says Kenso Soai at the Tokyo University of Science in Japan.

One issue is that phospholipids in cell membranes are also chiral, so one explanation for the findings is that left-handed membranes, say, only allow through left-handed molecules. But the team saw selection for right-handed deoxyribose and ribose whatever the chirality of the membrane, says Richards, so that can't be the full explanation.

"I don't doubt their data – this is nice work," says Nick Lane at University College London. But he is unsure how much it tells us about the origins of chirality.

Lane favours the idea that early life made chemicals such as amino acids and sugars itself, rather than acquiring them from external sources. If that was the case, the membrane-filtering effect might just be a coincidence, he says. Some other researchers, however, do think early life acquired many chemicals from the environment. ▮

Mirror images of hands, and molecules, can't be superimposed

SHUTTERSTOCK/CAROLSTPHOTO

Archaeology

Ancient plant artefact reveals how humans reached Australia

Michael Marshall

A TINY chunk of plant resin shows that people were living on an island in eastern Indonesia at least 55,000 years ago – indicating the likely route that modern humans took when migrating to Australia.

We know that modern humans journeyed to Australia by heading south-east from mainland Asia, travelling through what is now Indonesia and many other islands of South-East Asia. The exact timing is contested, says Dylan Gaffney at the University of Oxford. Modern genetic evidence suggests humans arrived less than 50,000 years ago, but archaeological evidence points to an earlier arrival, "perhaps 65,000 or even 80,000 years ago", he says.

The exact route they took is also disputed because the geography of the region at the time was different. Earth was in a cold glacial period, so more water was locked up in ice sheets and sea levels were lower, meaning some landmasses that are now islands were connected to continents. In the western part of this region, Borneo, Sumatra and Java were all part of mainland Asia – while in the eastern part, New Guinea was joined to Australia.

This means there were two routes humans could have taken to reach Australia. The northern route heads east from Borneo to Sulawesi and on to New Guinea, then south into Australia. The southern route goes via Java, passing through Bali and Timor to northern Australia.

To help find out how people made the journey, Gaffney and his colleagues excavated Mololo cave on the island of Waigeo, one of the Raja Ampat islands just west of New Guinea and along the northern route. In the sediments on the cave floor, the team found evidence of human occupation, such as charcoal and a few stone flakes.

DYLAN GAFFNEY/THE RAJA AMPAT ARCHAEOLOGICAL PROJECT

Recreation of a slice of tree resin (top) that may have been used to make fire on the island of Waigeo (below)

Gaffney's team also found a piece of resin 1.4 centimetres across. It has an angular shape, suggesting it was cut from a tree rather than pooling naturally. Radiocarbon dating indicates it is at least 55,000 years old (*Antiquity*, doi.org/ncqg).

The resin was probably used as fuel for fires, says Gaffney. "It is very flammable and is a good light source in caves." But there are other possibilities, such as fragrance or adhesive. Whatever its use, it shows that humans were on Waigeo at least 55,000 years ago. "We are demonstrating that people used the northern route," he says.

The work adds to evidence that people first reached Australia via the northern route, says Kasih Norman at Griffith University in Queensland, Australia. Geographical models always pointed to the northern route because the sea crossings are easier. "You have more water crossings between islands to do along the northern route, but the crossings themselves are shorter," she says, and "you can always see to the next island".

However, most archaeological excavations focused on the southern route, says Norman. Only in recent years have researchers begun exploring the northern option.

One key discovery, published in July, is that a cave painting of a pig found on Sulawesi, along the northern route, is 50,000 years old. Likewise, a study published in May found that there was no evidence of humans on Timor before 44,000 years ago, suggesting the southern route was only used later. ▮

TRISTAN RUSSELL/THE RAJA AMPAT ARCHAEOLOGICAL PROJECT

Zoology

Endangered skate saved by hatching eggs in captivity

James Woodford

ONE of the world's most endangered species of marine fish has been saved from extinction, thanks to researchers who captured wild specimens and helped them reproduce in captivity.

The Maugean skate (*Zearaja maugeana*) is found only in Macquarie harbour on the isolated south-west coast of Tasmania, Australia. The area is a naturally low-oxygen environment, making it difficult for fish to thrive, but salmon farming and river flow changes as a result of dams have made the situation worse.

Jayson Semmens at the University of Tasmania says while no one knows the exact population of these skates, a collapse between 2014 and 2021 saw it halve. There may now be just over 1000 individuals, he says, and they are now predominantly adults, meaning juveniles aren't reaching maturity.

To try to safeguard the skates from extinction, in December 2023 Semmens and his colleagues collected 50 eggs and saw over half of them successfully hatch in captivity. They also collected some adults, one of which laid eggs even though it was kept separate from the others. Semmens says this is because the skates are able to store sperm to fertilise eggs later. "We have over a hundred eggs from her now and the vast majority of them are looking like they're going to be viable," he says.

Team member David Moreno, also at the University of Tasmania, says captive breeding isn't the full solution, so the researchers are also working to reverse environmental issues in Macquarie harbour, including a trial of pumping oxygen into the water.

It will take four to five years before the captive-reared individuals reach maturity and could start contributing to the wild population when released. ▮

Quantum physics

New spin on quantum theory may force rethink of a fundamental law of physics

Karmela Padavic-Callaghan

QUANTUM reality just got stranger. A particle's angular momentum – its spin around an axis or rotation around a point – may be able to travel between two places by itself, disembodied from the particle. This finding may require a rethink of some of the most fundamental laws of physics.

Yakir Aharonov at Tel Aviv University in Israel likens it to the way the Cheshire Cat from *Alice in Wonderland* can move its body to one place while its smile remains elsewhere. "And here now we showed that physics actually realises this possibility," he says.

This quantum Cheshire Cat effect has been confirmed before. In 2014, an experiment first showed that a neutron's spin can be disembodied from the neutron itself. Similar findings followed, corroborating Aharonov's view of the quantum realm being its own sort of Wonderland. Now, along with Sandu Popescu and Daniel Collins at the University of Bristol in the UK, Aharonov has turned to investigating angular momentum more broadly at the quantum scale.

An object's angular momentum depends on its mass, velocity and size, and has traditionally been thought to follow a conservation law: it can never be created or destroyed, only redistributed. For angular momentum to move somewhere, it must be carried by an object. But now it seems that may not always be the case.

The researchers imagined a scenario where a particle with angular momentum is at the left edge of a long box that has a reflective wall in the middle. The particle bounces around the left half of the box, but in rare instances, it can pass through the wall via quantum tunnelling. They calculated how the properties of a particle starting on the left and moving right

FREDER/GETTY IMAGES

Unlike you, a particle can be separated from its momentum

would change after a long time.

They found that even when the particle is extremely unlikely to leave the left edge of the box – for instance, when it is very massive – its angular momentum could still change. The law of conservation of angular momentum suggests this must be accounted for by an equal and opposite change, transferred elsewhere by the particle. But the team found that despite the particle never being in contact with the box's right edge, that is where its momentum ended up.

Checking for signatures of possible contact between the two sides, such as a transfer of velocity from the particle to the wall, left the researchers empty-handed. They concluded that the angular momentum made it to the wall without anything carrying it.

"Suddenly, we had a situation in which a conserved quantity, which means more than some arbitrary property of the particle, can be disembodied from the particles to which it belongs, and can propagate from one place to another without any material support," says Popescu. The work will be published in *Physical Review A*.

Popescu says this has important implications for conservation laws, the bedrock of physics. Studying these in quantum theory is not at all straightforward, he says – at that scale, there are

"In quantum mechanics, the concept of a particle is more elusive than it is in conventional ideas"

fundamental limits to how precise measurements of things like the properties of a particle can be.

But even without perfect measurements, the finding may reveal something fundamental about the world. Aharonov says it signals that there are laws of physics that persist even when what we can learn about objects is uncertain. Indeed, the conventional idea of a particle as a knowable object doesn't mesh with quantum theory. "I think the idea is we have shown now that conservation laws are a deeper issue than the issue of particles," he says.

Holger Hofmann at Hiroshima University in Japan says the idea that conservation laws are more complex in the quantum realm is compelling, but a more detailed and nuanced analysis of the set-up presented by the researchers is necessary. "For this kind of research, it is important to understand that the conventional ideas of particles as physical 'carriers' of information does not work at all in quantum mechanics, where the concept of a 'particle' clearly means something more elusive and less tangible," he says.

To uncover the effect, the researchers used a process called "post-selection" in which they infer what must have happened to the particle in the past based on its state at a later time. They argue that the validity of their discovery is independent of this method. Aephraim Steinberg at the University of Toronto in Canada says some physicists still object to it, even though Aharonov has an extensive body of work on how such later actions can affect what we can know about a particle.

"These 'post-selected' experiments often lead to strange new effects and bear being thought about cautiously," says Steinberg.

He says the model makes definitive enough predictions to be tested experimentally, even though those would probably be technically challenging. Popescu and Aharonov say they are confident that experiments with quantum light or ultracold atoms could put the phenomenon to the test. Once that happens, we will have more certainty on how conservation laws work in the quantum Wonderland. ▮

Coronavirus

One mutation spread covid-19 variant

The JN.1 variant may have been able to escape antibodies because of a small genetic change

Carissa Wong

A SINGLE mutation may have been crucial to the JN.1 covid-19 variant spreading rapidly around the world last year, demonstrating how quickly the virus can adapt.

"A single mutation in JN.1 was key for it to evade the antibody response, and that's why it was able to spread," says Emanuele Andreano at the Toscana Life Sciences Foundation in Italy.

JN.1, a subvariant of the omicron variant, was first identified in Luxembourg in August 2023. At the end of January, it accounted for 88 per cent of the recorded infections in the US, 85 per cent of those in the UK and 77 per cent in Australia. Its predecessor, BA.2.86, never accounted for more than 5 per cent of known global infections.

With JN.1 and its descendants remaining the most reported covid-19 variants globally, Andreano and his colleagues wanted to investigate how it spread so widely. Genetic sequencing previously pointed to an additional mutation compared with BA.2.86 in its spike protein, which the virus uses to infect host cells.

To learn more, the researchers analysed 899 types of antibodies from blood samples previously collected from 14 people, all of whom had received two or three doses of an mRNA covid-19 vaccine and had confirmed infections with prior variants.

The researchers added each of these antibodies, along with BA.2.86 SARS-CoV-2 viruses, to a dish containing monkey cells. This revealed that 66 of the 899 antibodies were able to prevent BA.2.86 from infecting the cells. When they repeated the experiment with JN.1, just 23 of the antibodies prevented infection.

A computer simulation showed that JN.1's spike protein mutation caused a longer amino acid called leucine to be swapped for a shorter one called serine, which then weakened or blocked the body's antibodies from interacting with the spike protein (*Science Immunology*, doi.org/gt6qq3).

"A single mutation in JN.1 was key for it to evade the antibody response and enable it to spread"

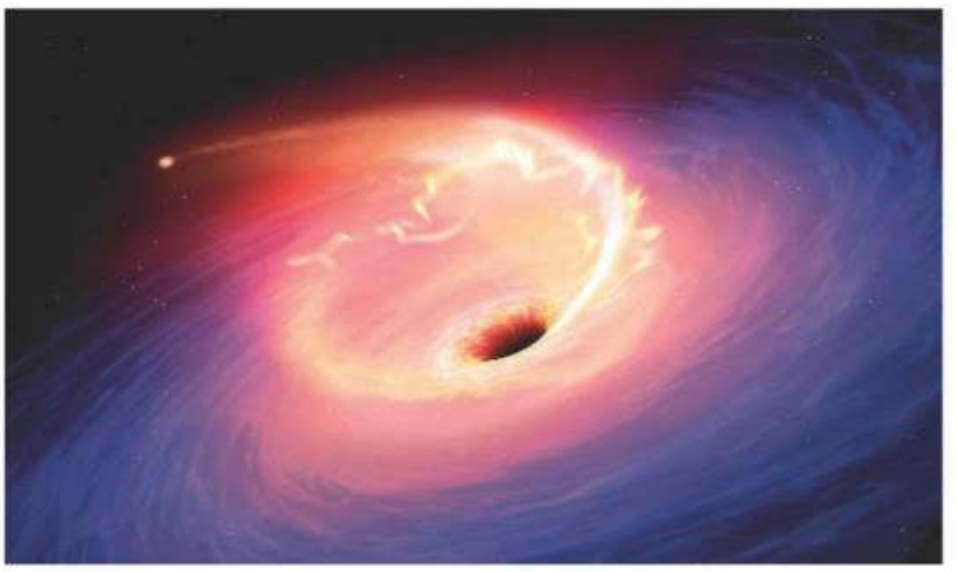
The antibodies that prevented JN.1 infections in the monkey cells came from five of the 14 blood sample donors. These individuals had "super hybrid" immunity, says Andreano, brought about from receiving three mRNA vaccine doses, being infected once by the original SARS-CoV-2 variant identified in Wuhan, China, and infected again by an omicron variant. Those antibodies may bind to other parts of the spike protein, away from the site of the mutation, thereby preventing a JN.1 infection, he says.

The study shows how a single mutation may have been key to JN.1's spread. Yet, it still doesn't cause more severe illness than prior variants, says Andreano.

That is probably because there are other prongs of the immune system, such as T-cells, that work to stop the virus from causing severe illness, says Jonathan Ball at the Liverpool School of Tropical Medicine in the UK. "Collectively, people's immunity is holding strong," he says. ▮

Astronomy

Black hole devouring giant star gives clues to a cosmic mystery



MARK GARLICK/SCIENCE PHOTO LIBRARY/GETTY IMAGES

An illustration of a tidal disruption event in which a black hole shreds a star

A SUPERMASSIVE black hole has been caught eating a huge star in the biggest example of this powerful event ever seen. It could help us understand mysteriously bright cosmic objects in the centres of some galaxies.

When a black hole gobbles up a star, it doesn't happen in one titanic gulp – instead, the star is torn apart in a violent process called a tidal disruption event (TDE). These are some of the brightest events in the sky. Edo Berger at the Harvard-Smithsonian Center for Astrophysics in Massachusetts and his colleagues have now found one that is nearly 10 times as bright as any seen before.

This TDE, called AT2023vto, is so bright scientists originally thought it was a supernova. However, when Berger and his colleagues conducted follow-up observations and more analysis of the original data, they found it was a much closer match to a star being ripped limb from limb. "It's much more energetic than any TDEs we've seen before and yet it behaves exactly like all of the other tidal disruption events," says Berger.

The researchers' models showed that AT2023vto was caused by a star about nine times as massive as the sun falling into a black hole about 10 million times as massive as the sun (arXiv, doi.org/ncks). Finding such a huge star so close to a supermassive black hole is rare.

"A star like this one has a lifetime of only about 10 million years or so, so in all likelihood it had to have formed in the vicinity of the supermassive black hole," says Berger. Studying events like this could help us understand the possibility of star formation there.

It could also help us figure out odd phenomena called ambiguous nuclear transients (ANTs), which are bright flashes from the centres of certain galaxies. Some researchers have suggested these may be a new type of TDE involving extremely massive stars. If that is ANTs' true identity, then this cosmic cataclysm could be the missing link between them and the less-extreme TDEs. ▮

Leah Crane

Environment

The climate impact of feeding ourselves is getting worse

Michael Le Page

FARMING'S climate efficiency gains have stalled since 2010, meaning emissions – and deforestation – could rise sharply as the world's population and demand for food continue to grow.

Lin Ma at the Chinese Academy of Sciences in Shijiazhuang and his colleagues have analysed existing data to estimate greenhouse gas emissions per unit of protein produced between 1961 and 2019. They chose protein rather than calories because it is a better measure of food quality, says Ma.

Between 1961 and about 2010, emissions per unit of protein fell by two-thirds, the team found. But since then, there have been no further improvements and there are even signs of an increase. Farming is responsible for about a third of all greenhouse gas emissions and demand for food is projected to rise by up to 50 per cent by 2050. If the climate efficiency of farming isn't rising, this means emissions from farming will rise by 50 per cent too (*PNAS*, doi.org/ncqj).

If efficiency isn't improving, the only way to increase production is to clear more land for farms, the researchers say, leading to yet more deforestation and biodiversity loss.

"That would be very bad news," says Richard Waite at the World Resources Institute in Washington DC. Keeping global warming to 1.5°C depends on ending deforestation as soon as possible, he says.

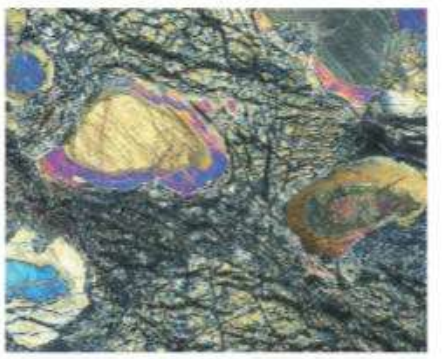
There are many reasons why climate emissions per unit of protein produced are no longer falling, says Dan Rejto at the Breakthrough Institute in Berkeley, California. One is that people are eating more meat, which entails more emissions than plant-based foods. Another is that lots of crops are now turned into biofuel, not food, and as such are calorie-heavy rather than protein-rich, reducing their efficiency as measured by Ma's team. ▮

Earth science

Record-breaking hole drilled 1.2 kilometres into Earth's mantle

Chen Ly

CLOCKWISE FROM TOP: IODP; JOHAN LISSENBERG; LESLEY ANDERSON



Anti-clockwise from top: The JOIDES Resolution ship has been drilling into the seabed; researcher Kuan-Yu Lin looks at recovered rocks; a slice of rock seen under a microscope

IN THE middle of the North Atlantic Ocean, geologists have burrowed 1268 metres below the seafloor – the deepest hole drilled into Earth's mantle yet. Analysis of the resulting rock core offers clues about how our planet's layers evolved – and perhaps even the origins of life.

Earth is broadly made up of a few different layers, including a solid outer crust, an upper and lower mantle and a core. The upper mantle, which sits just below the crust, is composed primarily of a magnesium-rich rock called peridotite. This layer drives key planetary processes such as earthquakes, the water cycle and the formation of volcanoes and mountains.

"To date, we've only had access to fragments of the mantle," says Johan Lissenberg at Cardiff University, UK. "But there are a number of places where the mantle is exposed on the seafloor."

One of these is an underwater mountain called Atlantis Massif near a volcanically active region of the mid-Atlantic ridge. Continuously surfacing and melting parts of the mantle give rise to many of the volcanoes in the area. Meanwhile, as seawater seeps deeper into the mantle, the hotter temperatures heat it up and produce chemical compounds such as methane, which bubble back up through hydrothermal vents and provide fuel for microbial life.

"There's a kind of chemical kitchen in the subsurface of Atlantis Massif," says Lissenberg.

To learn more about this, he and his colleagues planned to bore 200 metres into the mantle with the drilling ship JOIDES Resolution, deeper than had been managed so far.

"Things went amazingly well," says team member Andrew McCaig at the University of Leeds, UK. "We recovered really long sections of continuous rocks and decided to stick with it and go as deep as we could." Eventually, the researchers managed to reach a depth of 1268 metres.

They found that the drill core sample had lower levels of a mineral called pyroxene than other mantle samples collected from around the world (*Science*, doi.org/nckn). That suggests this part of the mantle has undergone significant melting in the past, which has depleted the pyroxene, says Lissenberg.

Reconstructing this process could help us understand how molten rock migrates to the surface to feed oceanic volcanoes, he says.

Some scientists think life on Earth began in the depths of the ocean near hydrothermal vents. So, by examining the chemicals in the core, microbiologists are hoping to determine the conditions that may have led to life and how deep beneath the ocean floor they occurred.

"It's going to be a reference section for scientists from many branches of science," says McCaig.

"A one-dimensional sample of the Earth cannot provide full information on the three-dimensional migration pathways of melt and water, but is nevertheless a major achievement," says John Wheeler at the University of Liverpool, UK. ▮

Technology

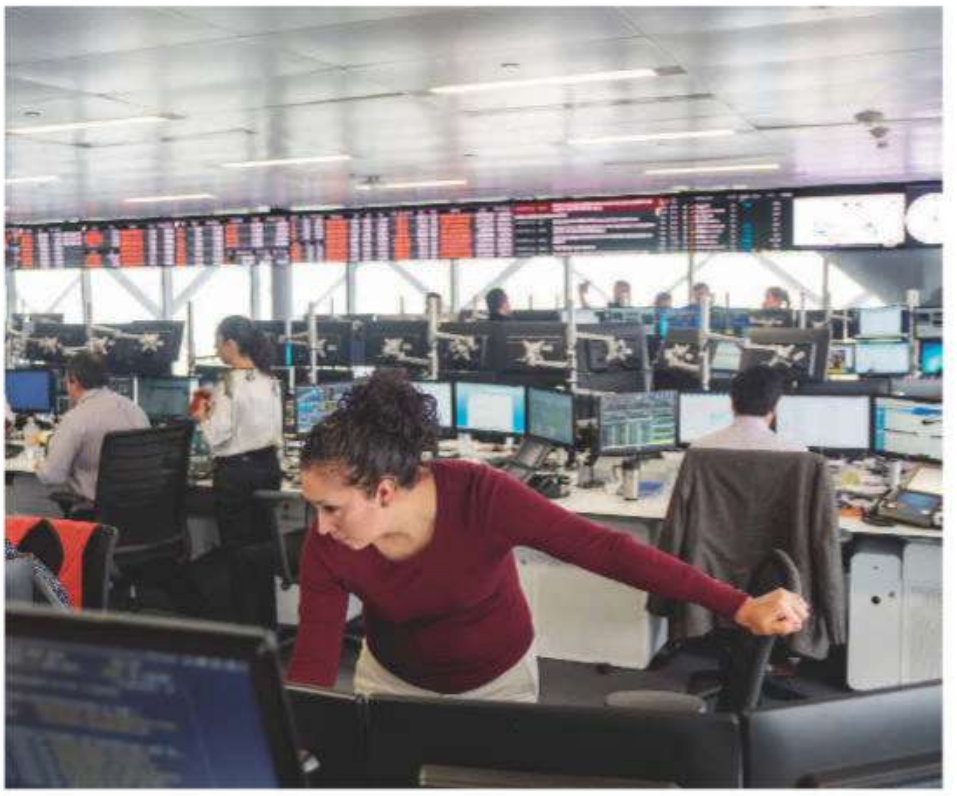
Quantum traders could beat market

Commercially available technology could let stock traders coordinate decisions using "quantum telepathy", and it could destabilise financial markets, finds **Karmela Padavic-Callaghan**

QUANTUM technology could shake up the stock market, allowing traders working at distant stock exchanges to coordinate decisions to buy or sell nearly instantaneously by using entanglement to create a phenomenon called "quantum telepathy" – and all the devices they would need already exist.

The idea takes advantage of a counterintuitive phenomenon that Albert Einstein dubbed "spooky action at a distance", in which two quantum particles can influence each other instantaneously across large distances. In the 1960s, physicist John Bell devised a test to confirm that our world really can support such non-local correlations, and experiments that followed his work cemented spooky action as a reality. They also opened the door for even stranger scenarios where particles seem to collude without having to communicate.

Now, independent researcher Dawei Ding and Liang Jiang at the University of Chicago in Illinois argue that this kind of quantum entanglement can be used to gain advantages in the stock market, using only devices that are already commercially available.



ALEX MAJOLI/MAGNUM PHOTOS

Speed of trading is crucial for financial markets

Every microsecond counts

"The equipment [that you would need] is very simple. These Bell experiments have been done since the 1970s, so it's very standard equipment. You see it in a lot of laboratories," says Ding.

He and Jiang considered high-frequency trading where trades happen in as little as millionths of a second. In their mathematical model, a high-frequency stock trader named Zhuo operates on the New York Stock Exchange (NYSE) and NASDAQ. The data centres of these stock exchanges are 56.3 kilometres apart. Zhuo has a physical server at each data centre, each of which modifies its selling and buying decisions only based on local information it receives at that exchange.

For the two servers to coordinate decisions, however, one must contact the other. The fastest that information can travel between them is at the speed of light, which would take 188 microseconds, or enough time for dozens of trades to be made. Ding says this delay could be minimised to just the time it takes to detect a particle's state if the two servers coordinated through what he and Jiang have called quantum telepathy – it is also known as quantum pseudotelepathy, a term coined a few decades ago by physicist Alain Tapp, as there is no actual telepathy occurring.

The new scheme relies on a pair of entangled quantum particles, such as particles of light, with one at each server. The quantum state of the two would be prepared so that interacting with one changes the other, as with everyday entanglement. The difference here is that the second particle's resulting change of state maps onto a set of pre-programmed trading decisions. For instance, if Zhuo wanted to hedge his bets, the entanglement could be prepared such that if a measurement of the particle at the NYSE returns a state that correlates with "buy", a measurement at the NASDAQ server would find its pair particle in a state that means "sell" (arXiv, doi.org/nb7r).

Ding says that unlike quantum computers, where definitive proofs of quantum advantage are rare, the argument for an advantage with quantum telepathy is mathematically clear-cut. Plus, devices that produce pairs of entangled particles can already be bought from several firms.

Ning Bao at Northeastern University in Massachusetts says the first company to use quantum telepathy for high-frequency trading could destabilise the market, which raises the question of regulation. "I think if you wanted to make a company to do this, you could do it within a year," he says. "It has the potential to circumvent the spirit of the law without circumventing the letter of the law."

A representative of the US Federal Trade Commission declined to comment on whether the agency is considering regulations for quantum stock market manipulation. The US Securities and Exchange Commission didn't respond to request for comment from *New Scientist*.

Ding says he and Jiang don't think their set-up will be used for market destabilisation. "Instead, we envision firms will engage in competition to incorporate this technology into the high-frequency trading world to make markets more efficient," he says.

He is excited by how immediately technologically feasible this research is, but says mathematical work remains to develop algorithms to determine optimal quantum telepathy schemes for trading situations beyond the simple hedging example. Ding is hoping to work with real-world trading data and researchers who specialise in related experiments to make quantum telepathy on the stock market a reality.

"My goal, in the end, is for this to be actually built," he says. ▮

56.3km
separate the NYSE and NASDAQ data centres

188
microseconds is the current time it takes data to pass between them

Forensic science

Satellite data is helping locate hidden graves of missing people in Mexico

Roberto González

THE most extensive model ever made for predicting the locations of clandestine graves could help track down the remains of the more than 100,000 people estimated to have disappeared in Mexico since 1962.

Ana Josselinne Alegre Mondragón is part of a team of researchers at CentroGeo, a geospatial research centre funded by the Mexican government that has been experimenting with using satellite imagery to identify the footprints left by covert graves.

"In most states, clandestine graves were more likely when obstacles blocked the view of the grave site"

Over the past few decades, the government and groups of relatives of those who have disappeared began to ask CentroGeo for help, says Alegre Mondragón. "So, we started looking for variables that could help us answer these questions."

They mapped the locations of known covert grave sites onto satellite imagery and combined it with data about the perpetrators and victims. For example, they used data about the areas of influence of drug cartels, which are known to be behind many of these disappearances, according to the United Nations. They also focused on migratory routes because the people who use them are often known to disappear in Mexico.

The model covered 30 variables, including road networks, bodies of water and urban settlements. Then the researchers created maps of 10 of the states most affected by disappearances, highlighting areas where covert graves may be more likely to be discovered.

For example, they found more potential for finding graves in areas with low population density and that were less than 46 minutes of travel time from roads in urban areas. In fact, 85 per cent of graves that have already been found were within 850 metres of a road.

"People are innately lazy. They will do the least amount of work possible to get what they need done", and this applies to selecting a covert grave site, says Victoria Berezowski at Deakin University in Australia.

But there were differences across the 10 states. For most, clandestine graves were more likely when visibility was low, for example when more obstacles, such as trees, blocked the view of the grave site. The exceptions were the three states of Michoacán, Jalisco and Guerrero, where this pattern was inverted (*Forensic Science International*, doi.org/nb7h).

Researchers in Mexico prepare to use a drone to search for graves

ANA ALEGRE (CENTROGEO)

Alegre Mondragón says this may be due to a high level of organised crime in these three states. The level of control they have over a territory means they aren't concerned about being found, she says.

Berezowski says the scale of conflict in an area may also play a part. Larger conflicts may not follow the patterns of smaller ones. "Often in these situations of mass conflict, the motive for burying [someone] in a mass grave is just to get rid of the evidence, so the variables that make sense for finding individual burials don't necessarily work for mass burials."

The assessment techniques are beginning to show success. An earlier model designed for the state of Baja California assisted a search last year that found two clandestine graves. ▮

Environment

Zigzag wall pattern could keep buildings cooler

WALLS covered with protruding zigzags could stay up to 3°C (5.4°F) cooler than regular ones, without using any energy.

"We can cut down energy consumption for cooling," says Qilong Cheng at Columbia University in New York. The approach would thus help limit global warming.

The use of air conditioning is surging as the world heats up and the number of people who can afford it rises, increasing emissions from energy use. As a result, many teams are trying to develop passive cooling solutions that don't require any energy. For instance, simply making roofs white so they reflect more sunlight can keep buildings and cities cooler.

This approach is even more effective if roofs are coated with materials that reflect most sunlight but emit infrared radiation within the atmospheric transparency window. This is the range of wavelengths that aren't absorbed by molecules in the atmosphere such as carbon dioxide, so don't heat the atmosphere.

ALISTAIR SCOTT/GETTY IMAGES

A building's design can influence its temperature

Cheng and his team's solution is to have walls with a series of protrusions running parallel to the ground with a zigzag shape. The upwards-facing zigs have a surface that emits lots of heat in the atmospheric transparency window, while the downwards-and-outwards-facing zags have a surface that reflects infrared heat rather than absorbing it.

To test the idea, the team built a 1-metre-high model with both zigzag and flat surfaces. When put outside in New Jersey during the summer, the zigzag surface was 2°C cooler, on average, over 24 hours than the flat surface, and 3°C cooler between 1pm and 2pm (*Nexus*, doi.org/nckf).

There are a number of cheap materials available with the right properties, says Cheng. Existing buildings could be retrofitted by adding corrugated panels. The interior cooling effect will vary depending on factors like the size of the building's windows, but simulations suggest it could be up to 2°C, reducing the energy needed for cooling by up to a quarter. ▮

Michael Le Page

Space

Could we make Mars habitable using clouds of metallic glitter?

Alex Wilkins

RELEASING glitter-sized metal rods into Mars's atmosphere could warm the planet enough to melt water and support microbial life.

Making the surface of the Red Planet suitable for Earth life, a process called terraforming, would be complex, but a crucial part of this is raising its surface temperature above its current frosty median level of -65°C (-85°F).

Some people have suggested installing mirrors above Mars's surface or pumping methane into its atmosphere, but these ideas are difficult to implement because the raw materials required would need to be sent from Earth.

Now, Edwin Kite at the University of Chicago in Illinois and his colleagues have found that relatively small dust clouds made from iron or aluminium rods mined from rocks on Mars could warm the planet by about 30°C (54°F) in a period of a few months or over a decade, depending on how quickly the particles are released.

These rods would each be about 9 micrometres long and 160 nanometres across. They could be carried by wind from the surface to the Red Planet's upper atmosphere, where they would then remain for around a decade, trapping heat from below and allowing sunlight through.

Kite and his team modelled how the rods responded to light and then fed this information into climate simulations, which showed that the increase in temperature and pressure would be enough for parts of Mars to sustain liquid water and potentially oxygen-producing bacteria (*Science Advances*, doi.org/nb5h).

Terraforming Mars would make it more like Earth

They also found that this warming would only need the rods to be released at a rate equivalent to water flowing through about 30 garden sprinklers, amounting to a total of 700,000 cubic metres of metal per year to achieve the required warming, or around 1 per cent of Earth's metal production.

"When we did the calculation, we found a surprisingly small amount of engineered dust would be required, much less than if you wanted the same amount of warming with engineered greenhouse gases," says Kite.

DETLEV VAN RAVENSWAAY/SCIENCE PHOTO LIBRARY

Although it would still be challenging to mine from Mars's surface, this technique is 5000 times more efficient than any previously suggested warming method, says Kite.

One uncertainty in the simulations is how the tiny rods might interact with water in Mars's atmosphere, which could cause unintended effects like water clumping around the dust and falling back to the surface as rain, reducing the warming.

It is an interesting idea and might work if the particles stay in the atmosphere long enough, says Manoj Joshi at the University of East Anglia, UK. But it would still involve a huge manufacturing effort, he says.

There are also ethical questions about whether we should do this to Mars's atmosphere, says Joshi. "Should we really be altering a planet in this manner?" ▮

Psychology

Many conspiracy theorists may not be real believers

LOTS of people who say in surveys that they believe conspiracy theories probably don't think they are actually true. This means attempts to assess the prevalence of these beliefs could be skewed.

Robert Ross at Macquarie University in Sydney and his colleagues have surveyed 1044 adults from Australia, who they contacted via market research company YouGov. They asked the respondents, who had an average age of 48, to rate seven conspiracy theories, marking them as either "definitely false", "probably false", "don't know", "probably true" or "definitely true". These included "the idea of man-made global warming is a hoax that was invented to deceive people".

Initially, 349 of the participants were considered conspiracy theorists because they said they believed at least one of the theories was probably or definitely true.

The team then used two methods to gauge if they were being sincere. First, one of the seven theories was "farcically bizarre", says Ross: "The Canadian Armed Forces have been secretly developing an elite army of genetically engineered, super intelligent, giant raccoons to invade nearby countries." If a participant said this was probably or definitely true, they were considered an "insincere responder".

Second, the researchers asked if the participants had answered any of the questions "randomly or insincerely". If they answered "yes", then they were also marked as insincere. Overall, 205 of the participants were considered to be insincere (PsyArXiv, doi.org/nb5g).

"Our question about giant raccoons was much more effective for identifying insincere responders than our direct question about responding insincerely," says Ross.

"Researchers need to remember that surveys are far from a perfect reflection into what's really going on inside people's minds," says Matt Williams at Massey University in New Zealand. ▮

"Our question about giant raccoons was much more effective for identifying insincere responders"

Conor Feehly

Health

Evidence mounts that sweetener erythritol raises blood clot risk

Grace Wade

THE low-calorie sweetener erythritol makes blood more prone to clotting. This may explain why it has been linked to a greater risk of heart attack and stroke.

Erythritol is a sugar alcohol found at low concentrations in fruits and vegetables that is about 70 per cent as sweet as sugar. Our bodies also produce the compound in small amounts. It contains almost no calories, making it a popular sugar substitute, especially in the US and Europe. For several decades, erythritol has been added to products such as chewing gums, beverages and baked goods.

> "The findings indicate that erythritol, but not sugar, increases the likelihood of blood clots"

Regulatory bodies like the US Food and Drug Administration and the European Food Safety Authority have long classified erythritol as safe, but a growing body of evidence indicates it may harm heart health. A previous study by Stanley Hazen at the Cleveland Clinic in Ohio and his colleagues of people susceptible to heart attack or stroke found that those who had high concentrations of erythritol in their blood had twice the risk of these conditions, compared with those who had lower concentrations. Animal studies have also shown that erythritol can prompt clotting.

To see if the same holds for humans, Hazen and his team collected blood samples from 10 people before and 30 minutes after they drank water with 30 grams of erythritol – about the average amount people in the US consume daily. They repeated the process in a separate group of 10 people, replacing the erythritol with 30 grams of sugar. The participants had no underlying health conditions.

The researchers found that the blood of people who consumed erythritol was more prone to form clots after they ingested the sweetener than before. The samples from those who drank erythritol also had higher levels of molecules that blood cells release during clotting. Sugar had no significant effect on blood clotting (*Arteriosclerosis, Thrombosis, and Vascular Biology*, doi.org/nb5d).

These findings indicate that erythritol, but not sugar, increases the likelihood of blood clots, says Hazen. This is concerning, given that medical guidance often recommends people swap sugar for low-calorie sweeteners like erythritol, he says. "I would argue it is a safer to drink a [sugar]-sweetened drink than an erythritol-sweetened drink in a patient at risk for clotting and having a heart attack or stroke," says Hazen.

VICTORIYA POPOVA/ALAMY

Erythritol is a popular sugar alternative

Alice Lichtenstein at Tufts University in Massachusetts says more research is needed to evaluate the risks and benefits of low-calorie sweeteners compared with sugar because the latter contributes to other health conditions, such as obesity and dental cavities. ▮

Zoology

The toll of bird deaths from building strikes

Corryn Wetzel

MORE than 1 billion birds in the US die from colliding with buildings every year – a significant increase from many past estimates.

The disorienting light from buildings at night, along with confusing reflections from glass during the day, can cause birds to fly into them. Many collisions happen with skyscrapers, but they aren't the main culprit – the majority of strikes are actually at buildings four-storeys or lower, and the problem has worsened in recent decades with increasing light pollution.

Earlier studies that counted dead birds on the ground next to buildings have estimated that hundreds of millions of birds die instantly in these collisions each year in the US. But missing from those death counts were birds that survived collisions and later died during rehabilitation care.

"We know that far more birds hit glass than we find dead beneath it," says Dustin Partridge at NYC Bird Alliance, a non-profit organisation that works to protect birds in New York City.

To get a more accurate idea of the impact that buildings have on birds, Partridge and his colleagues analysed collision records from 152 species of birds hitting more than 3100 buildings around the US east coast – a major bird migration corridor – ranging from single-family homes to commercial properties.

They also included data from nearby rehabilitation facilities that cared for injured birds following building strikes. Their analysis revealed that 60 per cent of injured birds taken to such facilities died (*PLoS One*, doi.org/nb5c). Taking this into account, they estimate more than 1 billion birds die from building collisions each year – more than double some past estimates of fatalities.

PETERPOLCZ/ISTOCKPHOTO/GETTY IMAGES

Big expanses of glass can confuse birds and lead to them crashing into buildings

Because the injuries birds sustain by colliding with buildings are often severe, Partridge wasn't shocked by the finding. "It's such a challenge to survive after hitting a window," he says. But he emphasises that rehabilitation care is giving many birds a fighting chance. "If a bird is lucky enough to have somebody find it and bring it to rehab, those are the best conditions possible," he says.

Although the study was limited to the US, a similar pattern is playing out around the world. "This is happening everywhere – building collisions are a global threat," says Partridge. The number of bird-building collisions is especially high during annual migration cycles, when billions of birds travel by night and are drawn in by artificial lights. North America alone hosts four major "avian superhighways".

Bird-proofing windows is relatively easy, says Partridge: turning off the lights at night, drawing the shades during the day or adding glass decals is often enough to save birds from a fatal crash. ▮

Technology

Smartphone flaw lets hackers or governments map your home

Matthew Sparkes

HACKERS, app developers and even government agencies could be using your smartphone to create a map of the room you are in and tell what you are doing. The security vulnerability uses data in the GPS signal and doesn't require access to data from the camera, microphone or accelerometer.

Soham Nag and Smruti Sarangi at the Indian Institute of Technology Delhi have been investigating if data other than location could be extracted from GPS signals when Android smartphone users grant an app access to their location.

GPS data carries not only latitude, longitude and altitude information but also about 40 other metrics that help devices boost accuracy, such as doppler shift – how quickly a receiver is moving relative to a satellite.

Nag and Sarangi created an artificial intelligence system called AndroCon that took all of this information from five types of Android smartphone and pulled out clues about the room or building the user was inside and where they were in it.

In one test, the pair collected more than 100,000 readings from multiple users with different phones, taken in locations such as a university dormitory, a sports stadium and a busy market. Various AI models were used to determine the type of location from the data, with at least one scoring accuracy of over 90 per cent.

In another test, the AI had to determine whether a user was sitting, standing, lying down or waving at the phone when the readings were taken. One AI model managed this with more than 97 per cent accuracy. Models were also able to use the data to extract floor plans of the room in which the readings were taken, and when tested for accuracy, one correctly identified key points such as stairs, lifts and empty corners over 90 per cent of the time (arXiv, doi.org/nb47).

MORTEZA NIKOUBAZL/NURPHOTO VIA GETTY IMAGES

AI can be used to plot out the room you are in and what you are doing from GPS data

The researchers only tested Android devices but believe any device that allows an app access to the various GPS metrics would be vulnerable.

Nag and Sarangi say the method is probably already being used by intelligence bodies like the US National Security Agency (NSA). "This is something an academic group can do," says Sarangi. "In the world of security, if something is doable... someone is doing it."

"Never underestimate intelligence services on what technologies they know about"

Kevin Curran at Ulster University, UK, says methods to extract more information from GPS signals could be of legitimate use in smartphone apps, and also that the signals are probably being used for other means already. "You never, ever underestimate the NSA and [other] intelligence services on what technologies they know about," he says.

Curran says it is also possible the technique is being used by firms to collect information that allows them to better serve advertising. "The only way to remain secure is not to have a smartphone," he says.

Google, developer of the most widely used version of Android, hasn't responded to a request for comment, but Nag and Sarangi say they disclosed the flaw to the company and were told that while engineers had replicated it, they didn't consider it dangerous enough to warrant entering in the public Common Vulnerabilities and Exposures database of security flaws or to be prevented with a software update.

The researchers want people to be aware of the issue so they can decide if the convenience of apps is worth the privacy loss. ▮

Microbiology

A wide array of bacteria lurks in our microwaves

James Woodford

THE microwave ovens sitting in kitchens around the world are home to a surprising diversity of bacteria, despite the radiation they emit.

Manuel Porcar at the University of Valencia, Spain, and his team obtained samples from 30 microwave ovens: 10 were from single-household, domestic kitchens; 10 from shared kitchens such as corporate cafeterias; and 10 from biology laboratories.

In total, the researchers found 747 different genera of bacteria within 25 bacterial phyla. The diversity was lowest in household microwaves and highest in lab ones.

Many of the bacteria found in shared and single-household microwaves overlapped, and were similar to the bacteria often found on human hands and in kitchens.

However, those in labs, where food wasn't cooked, were more distinct and were similar to the microbiome found in extreme, dry, hot and irradiated environments, such as on solar panels (*Frontiers in Microbiology*, doi.org/nb5b).

The researchers noted that some bacteria found in domestic microwaves, such as *Klebsiella*, *Enterococcus* and *Aeromonas*, may pose a risk to human health. However, they say the microbial population in microwaves doesn't present a greater risk than that on other common kitchen surfaces.

Although microwaves can heat up food and sterilise samples, the radiation they emit is non-ionising, so doesn't directly disrupt biological molecules. They only kill bacteria if they hit a high enough temperature. "They must be cleaned like the rest of the kitchen," says Porcar.

Belinda Ferrari at the University of New South Wales, Australia, isn't surprised that bacteria can live in microwaves. "They can survive in almost any extreme-exposure environment and they can adapt to everything," she says. ▮

Climate science

Modern jet contrails last longer

Passenger planes and private jets that fly higher may cause a greater climate warming effect

Michael Le Page

AEROPLANES that fly at higher altitudes can create longer-lasting vapour trails that are likely to cause more global warming. Since private jets and modern fuel-efficient jets fly higher than other passenger aircraft, these may be causing even more warming than previously thought.

The findings could help airlines work out which routes to fly to minimise contrails, says Edward Gryspeerdt at Imperial College London. "If we could predict the contrail-forming regions of the atmosphere well enough, you could route aircraft around them, which would reduce this effect."

In some conditions, the soot particles emitted by jet engines can seed the formation of ice particles in the wake of aircraft, forming clouds known as contrails that have an overall warming effect. As much as half of the warming effect of aviation is estimated to be due to contrails, rather than the carbon dioxide emissions.

How long contrails persist largely determines how much warming they cause. Gryspeerdt and his colleagues have combined satellite observation and flight data to match specific aircraft to contrails, and see how the type of aircraft relates to persistence.

64,000

aircraft flights were analysed to look at the contrails they created

This has only been performed on a small scale before. By using artificial intelligence, the team could analyse 64,000 flights. This revealed that private jets and more fuel-efficient jets, which typically cruise at around 12 kilometres (38,000 feet), a kilometre higher than other planes, are more likely to generate longer-lasting contrails (*Environmental Letters*, doi.org/nb48). "It was not what we expected," says Gryspeerdt.

Not all the soot particles a plane emits turn into ice particles, he says. The researchers think that when an aircraft flies higher, a higher proportion of soot particles seed ice particles, but the overall size of ice particles is smaller.

Smaller ice particles fall more slowly, so take longer to reach regions where the air is relatively warmer and where they sublimate back into water vapour. This means contrails persist for longer and cause more warming.

However, it isn't clear if the additional warming caused by longer-lasting contrails outweighs the avoided warming due to the lower fuel use of modern planes.

What is clear is that the impact of private jets is being underestimated. "They are having an even more outsized impact on the climate per passenger than we thought," says Gryspeerdt.

Because contrails are more visible over oceans, and the researchers had data from just one geostationary satellite, they looked only at flights over the western Atlantic, around Bermuda.

The findings may not apply to flights further north, for instance over Greenland and Iceland, says Gryspeerdt, because the air at high altitudes there is drier and contrails are less likely to form.

"The study highlights the significant non-CO_2 climate impact of aircraft operating at high altitudes," says Krisztina Hencz at Transport & Environment, an environmental advocacy organisation in Europe.

High altitudes are mainly used by long-haul flights, says Hencz, but long-haul flights have been excluded from a European Union scheme that aims to reduce non-CO_2 warming. It also shows the importance of switching to fuels that generate fewer soot particles, she says. ▮

Zoology

Leeches use lethal 'spiral entombment' move on worms

WHEN worms ball up together to protect themselves against predators, leeches can still pick them off using a special death spiral.

California blackworms (*Lumbriculus variegatus*), which live in shallow waters of swamps and marshes, swim ultra-fast and form tangled blobs made of dozens of worms when predators are near. This usually protects them, but *Helobdella* leeches have devised a way to feed on them anyway.

"What's been known is that leeches will just pick off worms [from these worm balls] like spaghetti," says Harry Tuazon at the Georgia Institute of Technology in Atlanta. But he and his colleagues observed them doing something that has never been seen before. "It was definitely a surprise," says Tuazon.

The researchers put leeches and blackworms in a Petri dish filled with water and recorded what happened. Analysing the recordings one frame at a time revealed that out of 36 attacks, leeches successfully captured the worm or broke off a part of it 18 times. In each of these, the leech used its whole body to execute what the team calls "spiral entombment".

This is where the leech latches onto a single worm with a sucker, then envelops the worm by folding its body into a spiral shape, like a cocoon. Once the thrashing worm is trapped within the contorted leech, the predator inserts an appendage and feeds on the worm's internal liquids (*Integrative and Comparative Biology*, doi.org/nb49).

HARRY TUAZON

A leech starting the process of grabbing and eating a worm like it is spaghetti

Tuazon says that larger leeches were the best at spiral entombment of worms swimming alone, and all leeches struggled when faced with the worm blob. The hunting technique could still work, but they had to get lucky – most of the time, any worm they grabbed would thrash and tangle with the others and consequently bring the whole undulating blob with it, he says.

"Nobody really sees what's going on under the water that much, but when you watch closely, it's intense what's going on. There's very aggressive movements, it's quite the warfare," says Tuazon. ▮

Karmela Padavic-Callaghan

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Views

The columnist
Rowan Hooper travels to the 2030s to talk to whales p22

Aperture
The cobalt mines displacing villages in the DRC p24

Letters
Population isn't really a factor in fairness of sport p26

Culture
A top astrobiologist searches the universe for alien life p28

Culture columnist
Simon Ings watches *Dis-Ease*, a film about our fear of illness p30

Comment

Alan Turing is writing...

Plans to create an interactive AI model of the legendary code breaker Alan Turing are reckless and problematic, says **Matthew Sparkes**

ALAN TURING was many things: a wartime hero, a computer scientist who pre-dated computers, the father of artificial intelligence and a persecuted gay man. Now, 70 years after his death, he will also become a museum exhibit in chatbot form.

Bletchley Park, the site where he worked as a code breaker during the second world war, is working with a UK company called 1956 Individuals to create an AI model that can "converse naturally with visitors" as Turing himself. The idea is to tell his story in an interactive way that grabs audiences. But is such a project ethical, respectful or even useful?

ADRIÀ VOLTÀ

Some late public figures have estates managing their image and works: Albert Einstein bequeathed the rights to his "literary property" to the Hebrew University of Jerusalem, which now benefits when he appears in advertising. In one ad, he promotes smart energy meters from the bath. Einstein had a sense of humour, though whether he would appreciate that particular ad can never be known. He chose to grant permission for his works to pass into someone else's control (the concept of public image rights didn't exist at the time). There is no indication Turing did this.

Dermot Turing, Alan Turing's nephew, has backed the project. He wasn't available for interview, but we must ask, as a society, if we are happy to let this happen without the subject's direct consent. Similar concerns arose when Authentic Brand Group, which owns the public image rights for several late celebrities, allowed an AI recreation of Marilyn Monroe.

These are thorny issues and they will continue to arise, even for those of us who aren't famous. Projects to recreate grieving relatives' loved ones from troves of their emails and texts have led to some experts suggesting that legislation is needed to prevent people being digitally reincarnated without their prior, living approval.

There is also the question of whether current AI can do Turing justice. We don't know how much of him will actually reside in this neural network or whether his surviving writing will be enough to train it to match his tone and opinions. Nor do we know how much of his complex story the model will be willing to address, or how sensitively it can do so.

Turing was charged with "gross indecency" by the state simply for being in a relationship with another man. When convicted, he was forced to choose between imprisonment or chemical castration. He was also stripped of his security clearance, a decision through which the UK foolishly deprived itself of Turing's genius. He eventually took his own life.

These are painful experiences that current AI models are incapable of tackling sensitively. Building this Pandora's box is ethically shaky and opening it to public display is reckless – the inevitable problems can be seen a mile off.

What would Bletchley Park's curators do if the model lashes out at those who did him harm – or, worse, condones them? What would AI-Turing have to say about Russia's invasion of Ukraine or the upcoming US election? No doubt safeguards would be put in place to prevent the model straying into controversial territory where his opinion can only be speculation, but then what purpose does a sanitised, gagged Turing serve in helping us understand the man?

The creators of this project tell me that they haven't yet built the model, but will be able to "carefully control the responses with pre-agreed answers, when triggered by certain keywords" so responses will never be inappropriate, steering away from opinions towards facts. But in a world where AI created by Google told people to glue cheese to pizza, what hope does Bletchley Park have of navigating this without incident?

Turing's legacy should be remembered. But the man himself – recreations included – should be left to rest in peace. ▮

Matthew Sparkes is a technology reporter at *New Scientist*

Future Chronicles

From the depths

This week, we journey to the early 2030s, when machine learning first allowed us to communicate with sperm whales. **Rowan Hooper** tells us what they have to say

Future Chronicles explores an imagined history of inventions and developments yet to come. Rowan Hooper is the podcast editor at *New Scientist* and author of *How to Spend a Trillion Dollars: The 10 global problems we can actually fix*. You can follow him on X @rowhoop

Invention
Speaking with whales

Timestamp
2030s

Tagline
Cetaceans gain a voice in world government

This column appears monthly. Up next week: Chanda Prescod Weinstein

WE HAVE known for decades that sperm whales are highly intelligent and social. They are the largest of the toothed whales, among the deepest divers, have the biggest brains of any organism and their immense heads hold one of the world's most powerful biological sonar systems.
We also knew that their audio communication was incredibly complex. Starting in the 2020s, we began using machine learning to decode what sperm whales were saying. By the early 2030s, we were able to talk with them.

Back in 2021, analysis of the logbooks of 19th-century whalers showed that the success rate of their hunts fell by more than 50 per cent after a few years. This was because whales shared tactics to thwart the hunters. They learned to swim upwind of the whalers, whose boats were wind-powered, and told other whales about their escape. Biologists suspected that whales really did "talk" to each other, but how? The language was so alien it wasn't until artificial intelligence was put to work on larger datasets that we were able to make sense of it.

Cetaceans use specific names for themselves and other individuals. They also use arbitrary names for objects. In 2023, the first "conversation" took place between a human and a whale, a humpback called Twain. It took the form of an exchange of contact calls made by the whale and by a human via an underwater speaker, but the meaning of the exchange wasn't known.

The first breakthrough came in 2024. Analysis of thousands of recordings of sperm whale calls showed that the animals had 18 distinct patterns of clicks, known as codas. The codas – basically a phonetic alphabet – could be combined and modified in hundreds of different ways, and deployed in sequences akin to sentences in human language.

But it was the combination of more recordings of sperm whale clicks in the late 2020s, and analysis using machine learning, that opened the door to understanding. What happened next amounted to first contact – engaged conversation with a nonhuman intelligence.

The first word decoded by machine learning turned out, unsurprisingly, to be "squid". Sperm whales hunt together, dive together and eat together.

"The first sperm whale word decoded by machine learning turned out, unsurprisingly, to be 'squid'"

Conversations frequently concerned arrangements for the location and timing of dinner. And the menu. Sometimes a whale would interject with calls that were decoded as meaning shark, or fish, or skate. Younger whales expressed boredom if yet again they were dragged to the same feeding grounds, and excitement when introduced to a new, exotic item, such as reef shark.

Another key topic of communication was around migration, or what whales call "the moving". Older whales in the group discussed routes to breeding grounds and safe areas, and threats on the way, such as chemical pollution, noise and human activity. Alliance-making helps maintain group cohesion and some whales specialised in talking politics. Since sperm whales have global distribution, they were able to adapt to the climate crisis by moving to more suitable areas. Phrases in their language ("the too-warm zone", "the lost parts") were identified as relating to regions rendered uninhabitable by ocean heating.

Sperm whales live for 70 years or more: females in groups with children and other female relations, and males in bachelor pods. The drawn-out process of male puberty, which lasts between the ages of 10 and 20 in sperm whales, takes up much of the conversational space in bachelor pods. A male mates for the first time in his late 20s, and the young guns boast and gossip just as pubescent human males do in a similar social situation.

Whale fiction typically concerns adventures into the deep ocean, coming-of-age stories, encounters with legendary whales and, of course, love stories. Songs and stories are told to prepare young whales for life, to entertain and to educate. Some of the oldest whales tell stories of encounters with whaling vessels in their youth, using language representing whalers as "death from above".

The impact of establishing communication with nonhumans led to, first, the animals and their culture being given UNESCO World Heritage status and, later, whales being given an honorary position at the United Nations. Animal rights in general became an accepted and ordinary part of human culture; welfare improved, and exploitation and indeed consumption of animals dropped from the mid-21st century.

Some whales worked with humans as ambassadors, earning money that was invested in ocean protection. Some marketed their songs to people. One of the most popular expressed the (to us) unfathomable joy and thrill of diving 3000 metres. ▮

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On the edge

Photographer **Pascal Maitre**
Agency **Panos Pictures**

THESE stark images tell a dark tale about the mining of cobalt, one of the most prized minerals of the modern technological age.

Taken near Kolwezi in the Democratic Republic of the Congo, a major cobalt reserve, Pascal Maitre's photos draw attention to the huge appetite for this metal. This is driven by its high stability and energy density, which make it suited for use in everything from lithium-ion batteries for electric vehicles to superalloys. The demand has led to corporations setting up vast extraction operations in the region, displacing villages.

The main image shows villagers in Tshabula, about 10 kilometres from Kolwezi's centre, searching for cobalt among the waste dumped on the embankments of one of the largest open-cast mines in the area. It is run by the state and the company COMMUS (a wider view of the mine can be seen in the inset image). The complex is set for an expansion that will destroy much of the housing nearby.

But not all the mines in the region are official. Some have taken this lucrative practice into their own hands, digging deep tunnels. There are government schemes to regulate this trade and improve working conditions, but the 150,000-odd "artisanal" miners around Kolwezi receive little pay for their efforts.

Gege Li

Editor's pick

Yet another reason to put ocean mining on hold

27 July, p8

From Briony Venn, Greenpeace UK

It is rare to see a study influence both the news and political agenda so quickly as the finding of "dark oxygen" production by polymetallic nodules in the deep sea.

This research represents yet another reason why there must be a precautionary pause on deep-sea mining, a point made at recent International Seabed Authority meetings in Jamaica. Delegates from Belgium, Costa Rica and Panama, backed by scientists, took to the floor to highlight the significance of the discovery.

More countries have joined the call for a precautionary pause. We can only hope that the UK government, among others, is listening and will also be prepared to speak out on the world stage against this destructive industry.

From Ed Prior, Williamsburg, Virginia, US

While there are those who suspect contamination in the finding of oxygen production in seabed metallic nodules, I agree with Paul Dando at the Marine Biological Association that mining should be shelved until we understand the ecology of these places.

There may be another reason for caution. You outlined research (12 August 2023, p 16) that indicates seabed metals may catalyse a reaction at low temperatures that locks away as much as 4 million tonnes of carbon each year.

Population isn't really a factor in fairness of sport

Leader, 3 August

From Toby Pereira, Rayne, Essex, UK

Having read your leader on inequalities in sport, I would say that it is a statistical inevitability, rather than unfairness, that a country with a large population will (all things being equal) have more sports stars than one with a small population. This is the same for any field of endeavour. Is it a problem that there are more scientists from the US than from Monaco? Clearly not.

Can artificial intelligence predict its own trajectory?

3 August, p 18

From Jim McHardy, Clydebank, West Dunbartonshire, UK

You report artificial intelligence's ability to predict dangerous tipping points in complex systems, such as stock markets. Will it predict and tell us when it is going to take over and unleash our own weapons on us, or create new viruses leading to the extinction of most human life?

Two reasons humans are different to other animals

3 August, p 32

From Mike Mason, Oxford, UK

When considering what makes us human, there is a different way of looking at things. Clearly the journey from non-human apes to us is a continuum, but there are two features that seem undeniably human. We are the only species to truly harness energy other than from what we eat. The second, somewhat more shameful, marker is that we are the only species to produce waste that by and large isn't useful to another species in some way.

Darkening of ice could hasten current collapse

20 July, p 8

From Mike Bell, Woolacombe, Devon, UK

When it comes to ice melt changing currents in the Atlantic Ocean that help keep northern Europe relatively mild, there is another factor at work beyond rising temperatures. Wildfires in North America are burning at ever-increasing rates. Much of the ash and soot is deposited on the Greenland ice sheet, changing its albedo and vastly increasing solar absorption and therefore melt.

For more on climate impacts in the oceans, see page 32.

Getting hands on with some Stone Age cooking

3 August, p 20

From Hilda Beaumont, Brighton, UK

Hands-on experiments to understand Neanderthal food preparation reminded me of my time working with a class of reluctant 14 and 15-year-olds. We were studying early "man", including flint tools. I acquired some large flint nodules and the students could try making simple tools – harder than it looked – then use them in various ways.

This included creating sparks to light a fire, cutting pieces from a chicken breast and cooking them as kebab sticks over a fire they had made. The main impact was giving an appreciation of the knowledge and skill early humans must have had to survive and prosper.

You've just invented a new genre of writing

20 July, p 22

From Lindsay Turnbull, Oxford, UK

I have been reading *New Scientist* for decades and love it deeply – but in Rowan Hooper's Future Chronicles, I have found one of the most imaginative and creative approaches to writing in years. The mix of science and speculative fiction is a new genre: "futurism science reportage". It brilliantly paints a positive and hopeful picture. Bravo!

For more Future Chronicles, see page 22.

Take the long route to the photocopier

27 July, p 34

From Nick Baker, Rowhedge, Essex, UK

I was heartened to read that the benefits of exercise start at low levels. I was once involved in monitoring the exercise people get while doing normal office duties. It often amounts to as much or more than they get in their free time, so office design and practice could significantly improve health. Mobility around the workplace would need to be encouraged. In one typical case, we calculated energy expenditure lost due to intra-office email communication compared with face-to-face meetings, amounting to 13 per cent of the daily total.

Anti-ageing downsides could be monumental

Leader, 6 July

From Dyane Silvester, Arnside, Cumbria, UK

It seems premature to say that the downsides of anti-ageing therapies are a price worth paying. If they include a population explosion that turns out to be the last straw for an already overburdened planet, I suspect that the people alive at that time would disagree.

For the record

In the UK, around 60 per cent of 6-year-olds are moderately to strenuously active for an hour a day, but that drops as they age – by 2.5 minutes per day each year (27 July, p 42).

A helium II ion involves the removal of a single electron (3 August, p 36).

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Is ET coming into view?

It is time to expect the unexpected. **Graeme Green** explores the universe and the possibilities of alien life in a new book by a leading astrobiologist

MARK GARLICK/SCIENCE PHOTO LIBRARY/ALAMY

An artist's impression of a rover exploring the surface of Mars

Book

The Secret Life of the Universe

Nathalie Cabrol

Simon & Schuster (UK); Scribner (US)

DAVID BOWIE wasn't the first or last to wonder if there is life on Mars. The question of whether we are alone in the universe is still a great mystery. Some believe aliens have been visiting our planet for millennia, live among us and have even infiltrated the White House and 10 Downing Street.

For the more scientifically minded, there are authoritative voices like that of Nathalie Cabrol. She is one of the world's leading astrobiologists and director of the Carl Sagan Center at the SETI Institute in California. Cabrol also develops strategies for NASA's explorations of Mars and Saturn's moon Titan, and researches areas such as how life can survive in hostile environments.

That mission to explore life off-Earth fuels *The Secret Life of the Universe: An astrobiologist's search for the origins and frontiers of life*. We are, she writes, "living in a golden age in astrobiology, the beginning of a fantastic odyssey", guiding readers on a colourful tour of Earth, our solar system and the universe's distant corners, stretching back 4.6 billion years.

Her two main lines of enquiry – the origin of life as we know it and the search for other life – aren't truly separate. As the astronomer Carl Sagan, after whom Cabrol's centre was named, once said, these are "two sides of the same question – the search for who we are". Cabrol calls that sprawling endeavour "a balancing act of microscopes exploring the most elemental bricks of life and radio telescopes searching for advanced extraterrestrial civilizations in the farthest reaches of the universe".

Our understanding has increased dramatically in recent decades. We are the first humans to see Earth from afar. Voyager I's "pale blue dot" image of Earth from 6 billion kilometres away and the discovery of thousands of exoplanets have transformed our view of ourselves and our place in the universe.

"We might be the Martians we so relentlessly strive to discover, according to Cabrol"

Finding even the smallest of microbes on another world would be incredibly important in terms of potential intelligent life in the universe, says Cabrol. She also explores the possibility that, rather than life originating on Earth, rocks from Mars could have carried organic molecules or even primitive organisms to Earth, where they found more favourable conditions: "We might be the Martians we so relentlessly strive to discover," writes Cabrol.

Her book is full of such wonders. Cabrol clearly communicates big ideas and condenses decades of exploration and research into fast-paced chapters, with references to the likes of *Star Wars* worked in. She celebrates advances in our technology and knowledge, looking forward to the next two decades when remote missions will return samples to Earth and giant space and ground-based telescopes, including the James Webb Space Telescope (from which Cabrol says "nothing short of a quantum leap" is expected), will drive understanding forward again. We could, she says, even land a crew on Mars in a decade.

While Cabrol allows for the prospect that humans are alone in the universe, she thinks it is unlikely. The universe could be "teeming with federations of galaxies, time travellers, stellar harvesters... curious beings like us, born from the same universe, related to us by stardust, but separated by light-years".

Alien worlds may be "hiding in plain sight" in our sky, and we could find the first evidence of past or current life in the coming decade, writes Cabrol. Indeed, we may have already encountered alien communications too advanced for us to recognise. Chances are that any first contact would be with "pioneer extraterrestrial robots" rather than living beings, she writes.

She sounds notes of caution, too, reminding us of Stephen Hawking's fear that the messages scientists are sending into the universe might be "heard" by advanced and unfriendly aliens. Then there is artificial intelligence, which might complicate how we see intelligence at all.

The Secret Life of the Universe is a reminder of how far we have come and how fast. We are at the start of our journey to understand life and the universe. As Cabrol says, the best approach for future research is to "expect the unexpected". ▮

Graeme Green is a writer based in Derbyshire, UK

Dentition is destiny

From the scary mouths of hagfish to tooth-like structures on bodies, a history of teeth is serious fun, finds **Richard Smyth**

Book

Bite

Bill Schutt

Algonquin Books

OUR evolutionary history bears the bite marks of our teeth. And not just on our outcrop of the mammalian divergence, but across a vast range of animals, extinct and extant, backboned and not, evolutionary development has been shaped, gnawed, chewed and chomped by teeth. Dentition is destiny.

This is one of the most arresting ideas in zoologist Bill Schutt's *Bite: An incisive history of teeth, from hagfish to humans* – an engaging trans-species chronicle of teeth of all kinds. It is a book that is as interesting – perhaps more – when it strays off-topic, which is just as well, as Schutt, a bat biologist by profession, isn't interested in just giving us the tooth, the whole tooth, and nothing but the tooth.

We begin, enthusiastically, with vampire bats (which actually have fewer teeth than other bats), and move on to explore the distinction between mouth-based teeth to tooth-like projections elsewhere on the body. On the candiru fish of the Amazon, for example, they are located on gill covers and behind the mouth; this isn't in itself all that interesting, until we learn that the candiru – with a head about 13 millimetres wide – is claimed to use these external teeth to grip and wriggle up the urethras of bathing humans. We don't learn a great deal about teeth or external equivalents in the several pages Schutt spends on the candiru, but sometimes a science writer has to give the public what they want.

Schutt is interesting and amiable, whatever his topic. His explanations of the evolution of teeth – how some creatures acquired them, and how others, like birds, lost them – are lucid and insightful (chickens, he writes, may have the genes for forming teeth, but these have been long since "turned off").

There are fascinating deep dives into the development of horse teeth (which had to change fast, in evolutionary terms, to handle coarse, silicate-rich grass) and the interrelation between tusk growth in elephants and their poaching, hunting or domestication by humans. Digressions into mercury build-up in Arctic food chains – where Inuit people take the biggest hit of all – and the effects of snake venom are just as fruitful.

At times, Schutt's habit of not simply quoting from a source or citing a paper but instead staging a short, chummy dialogue with a researcher grows a little wearisome. Though on the other hand, one of his strengths is showing us science as a living discipline, whether in the form of John Hunter implanting a tooth into a cockerel's comb in the 18th century, or modern-day researchers battling with the practicalities of measuring the bite force of hyenas.

We also learn that teeth haven't only shaped evolutionary change but have also been fundamental in our understanding of it. "The fossil record of the great apes... over the past several million years is almost entirely understood from teeth," researcher Tanya Smith tells Schutt.

The final section on the history of human dentistry might fit better in another book, but overall, *Bite* is an enjoyable, often engrossing study of its toothy theme. It is also a compelling demonstration of how biological science is done, as Schutt sifts deftly through layers of research, extrapolation, interpretation and hypothesis.

He also finds time to quote James Brown, the godfather of soul ("Hair and teeth. A man got those two things, he's got it all"), and to walk us through the plot of his favourite 1950s schlock horror movie, *The Killer Shrews*. This is as it should be: a good science writer should eat omnivorously.

Richard Smyth is a crossword compiler for *New Scientist* and the author of *The Jay, The Beech and the Limpetshell: Finding wild things with my kids*

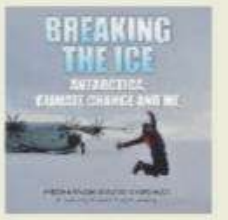
MICHAEL & PATRICIA FOGDEN/MINDEN PICTURES/ALAMY

The common vampire bat (*Desmodus rotundus*) actually has fewer teeth than most bats

New Scientist *recommends*

Alison George
Features editor
London, UK

I have been enthralled by and weeping my eyes out at a mesmerising memoir called ***Breaking the Ice: Antarctica, climate change and me*** by David Vaughan.



The vast sheet of ice covering Antarctica holds the fate of humanity in its hands: if it melted, sea levels would rise nearly 60 metres. And we have a better idea of how likely that is, thanks, in part, to the work of Vaughan, who studied the dynamics of this ice for nearly 40 years until his untimely death last year.

He leaves us the inside story of working in the remotest and most forbidding places on Earth – such as the Thwaites glacier, often dubbed the doomsday glacier, as it buttresses much of the West Antarctic ice sheet. This glacier was a key focus of Vaughan's work because of the dire consequences for Earth's coastal cities if it collapses.

Equally profound are his short personal essays, including one about his cancer diagnosis and how he managed to keep "buggering on", despite the odds.

The film column

Powers of perception

A documentary that started life during an artist residency at the UK's Wellcome Trust uses strong visuals and compelling interviews to argue that our conception of disease affects how we deal with it, says Simon Ings

Simon Ings is a novelist and science writer. Follow him on X @simonings

MCGRAW HILL VIA PERISCOPE FILMS

Mosquitoes have become part of a double-edged "war on disease" narrative

THERE aren't many laugh-out-loud moments in Mariam Ghani's documentary about our war on germs. But the sight of two British colonial hunters in former Ceylon bringing down a gigantic papier mâché mosquito is a highlight.

Ghani intercuts such public information films (a rich source of inadvertent comedy) with monster movies, documentaries, thrillers, newsreels and histology lab footage to tell the story of an abiding medical metaphor: the body as citadel, beset by germs.

Dis-Ease, which began life as an artistic residency at the UK's Wellcome Trust, is a visual feast, with a strong internal logic. Left to stand on its own feet, it might have borne comparison with Godfrey Reggio's *Koyaanisqatsi* or Simon Pummell's *Bodysong*: films that convey their ideas in purely visual terms. But Ghani is as devoted to the power of words. Interviews and voice-overs abound. The result is an unsatisfying collision of documentary styles.

Yet there is little in *Dis-Ease*'s narrative to take exception to. Humoral theory (in which the sick body falls out of internal balance) was central to Western medicine up to the 19th century, when it was superseded by germ theory, in which the sick body is assailed by pathogens. Germ theory enabled global advances in public health and was most effectively conveyed through military metaphors.

Dis-Ease reveals how "wars on disease" mutate into wars on groups of people. A "war on disease" also preserves and accentuates social inequities through its prevailing assumption that outbreaks spread from "developing" south to "developed" north, and the north responds with tech fixes that move south.

"Since adopting germ theory, we have managed life with death, but we should manage life with life"

At its very founding in 1948, the World Health Organization argued against this, and the eradication of smallpox in 1980 was achieved through international consensus by funding primary healthcare worldwide. Eradicating polio, begun in 1988, has been more problematic, and the film argues this is due to wealthier countries imposing a narrow medical brief (paying for vaccines rather than basic aspects of healthcare) even as countries were under pressure to privatise their health services.

Ecosystems are being eroded and zoonotic diseases now emerge more frequently. Well-coordinated military responses to frightening outbreaks are understandable and can be effective. For example, to criticise the British and Sierra Leonean military intervention in 2014 to set up a National Ebola Response Centre would be to put ideology before common sense. But, argues the film, such actions can backfire, absorbing cash that might have bought essentials.

In one interview, the sociologist Hannah Landecker says that since adopting germ theory, we have managed life with death, but that we should manage life with life, using our knowledge of the complex microbial world to ensure health, not fight disease.

What this means is beyond the scope of Ghani's film, and some gestures it makes towards a "one health" model of medicine – as illustrated by a hippy couple repeating the refrain "life and death are one" – caused this reviewer some discomfort.

Dis-Ease ends up as a snapshot of what desk-bound academics, rather than field researchers, think about disease. Many talk sense, though a special circle of hell is reserved for the one who, after reading too much science fiction, says glibly we can be cured "by becoming something else". ▮

Film

Dis-Ease

Mariam Ghani

Distribution pending

Simon also recommends...

Game

Pandemic

Matt Leacock

Matt Leacock Games

This board game, based on a SARS outbreak of the early 2000s, gives players a taste of life in the US Centers for Disease Control.

Book

The Magic Mountain

Thomas Mann

Vintage Classics

The first world war interrupted Thomas Mann's writing of this huge novel, a philosophical masterpiece about health and sickness, and the way people and communities are institutionalised.

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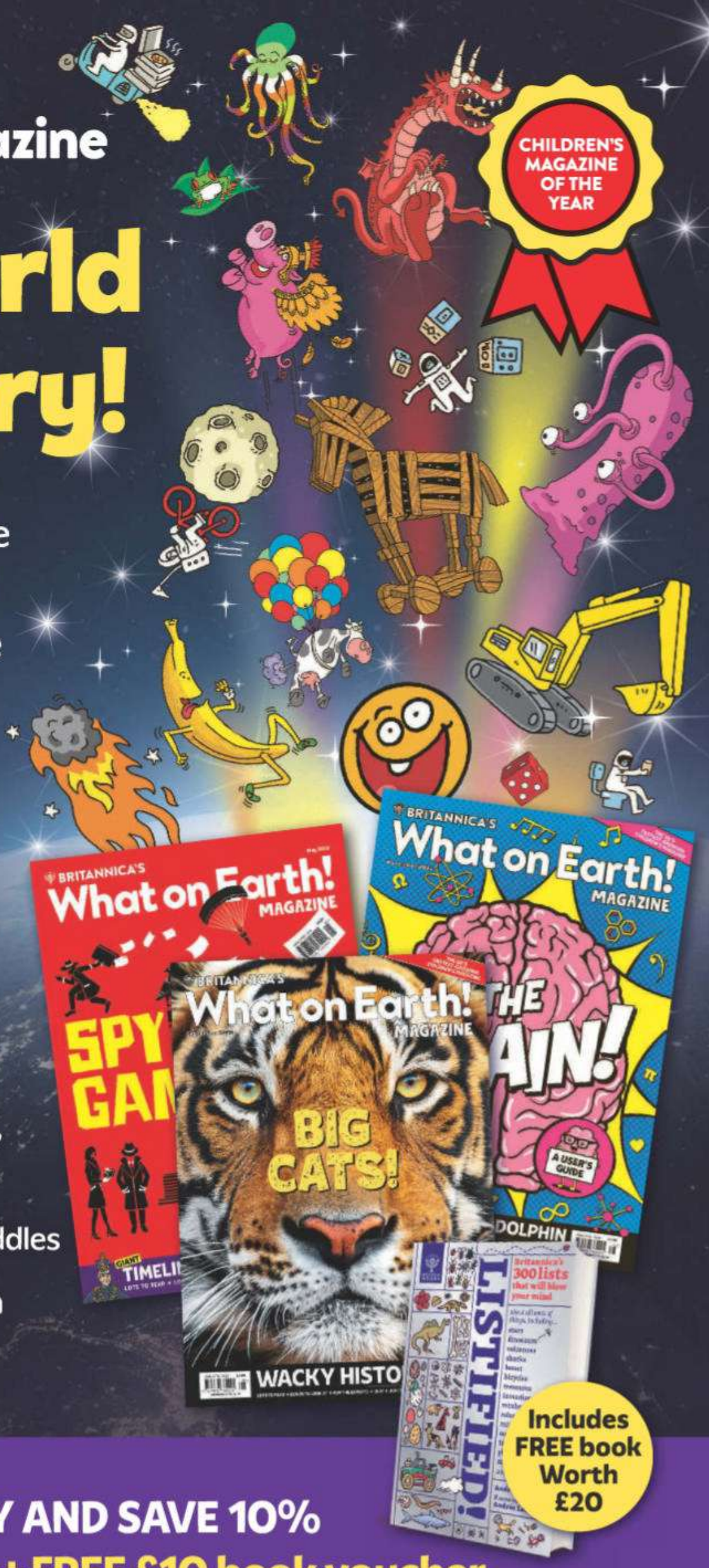

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Ocean chaos

The world's oceans are warming at an alarming rate, with disastrous consequences for marine life and humanity, reports **Madeleine Cuff**

THIS time last year, Dean Grubbs and his colleagues were celebrating a conservation success story. The star was the smalltooth sawfish, a type of large ray with a saw-like snout trimmed with tiny teeth. A victim of coastal development and bycatch, in 2003 it became the first sea fish to get US federal protection under the Endangered Species Act. By 2023, Florida's population of sawfish, the last in the US, was on the rise. "We were excited. We were seeing the population start to recover," says Grubbs, a marine ecologist at Florida State University.

Then disaster struck. In January, sawfish were spotted thrashing in the shallows, spinning in frenzied circles and turning up dead. This came after months of smaller fish showing similar behaviour. Suddenly, Grubbs and his team were spending their days pulling dead sawfish out of the water. Only after months of investigations and tests is a culprit emerging: ocean heat. A record-breaking heatwave brought "hot tub" water temperatures to Florida's coast in 2023, triggering a chain reaction that looks to have decimated the fragile sawfish population.

This is just one salutary tale. Something isn't right in the world's oceans. From orange algal blooms in the North Sea and a boom in gelatinous Bombay duck fish off China to disappearing "bottom water" in the Antarctic, there is growing evidence that extreme temperatures are wreaking havoc in our waters. After years of the oceans acting as silent sinks for excess human-caused heat, they are starting to creak under pressure – and we are finally waking up to how worried we should be.

Around 90 per cent of the excess heat trapped in the atmosphere since the industrial revolution has been absorbed by Earth's oceans. They have, in effect, been doing us a huge favour by shielding life on land from its effects. "This means it's not in the atmosphere, it's not melting the ice sheets and it's not warming the soil," says Till Kuhlbrodt at the Met Office, the UK's national weather service. This heat-storing service comes with a cost, though. For decades, sea temperatures have been steadily climbing. Between 1993 and 2022, global average sea surface temperatures rose by about 0.42°C per decade, says Gregory Johnson at the US National Oceanic and Atmospheric Administration (NOAA). But in March 2023, ocean temperatures began to rocket. "Global sea surface temperatures rose by about 0.28°C in just five months," he says.

Climate change must share a large portion of the blame, but climate variability has compounded the problem. In 2023, an El Niño weather pattern developed, bringing warmer sea surface temperatures to parts of the tropical Pacific. This followed an unusual "triple dip" La Niña – three consecutive years of cooler waters in the Pacific, during which heat would have continued to build up deep below the surface. "You have three years of La Niña, you follow up on that with an El Niño and bang! The temperatures warm up," says Johnson. "That's something that caused this jump to be larger than normal."

The effects have been dramatic, too. From January 2023 to May 2024, mass coral reef bleaching was confirmed in at least 62 countries and territories around the world. Such bleaching is a direct result of warming waters, with corals known to be at risk if temperatures climb by 1°C or more above their summer maximum.

Other changes – just as worrying – are less predictable. In Florida, researchers spent months trying to understand what was behind the mysterious sawfish deaths. The answer lay in the silty seabed. Down in that muddy layer lie bottom-dwelling, or benthic, algae, generally "minding their own business", says Alison Robertson at the University of South Alabama. Some of these algal species produce toxins that can affect marine life, but their numbers are usually kept in check by other resident algae. However, when Robertson was called to Florida to investigate the sawfish deaths, sampling of the water yielded surprising results. "The level of these microalgae was elevated, not only at the benthos but also in the water column, which is very, very strange," she says. The samples also revealed multiple different kinds of toxin-producing algae. "What we seem to have is a multi-stressor problem, with lots of different algae producing lots of different toxins," she says. "The combined exposure of all those things causes the behaviour."

Roberston and her colleagues think Florida's marine heatwave in 2023 acted as a trigger event, disrupting the ecosystem and giving toxin-producing algae an opportunity to become dominant. That would explain why many different fish species – more than 50 – were seen displaying symptoms of neurotoxin poisoning. Sawfish may have been the hardest hit of larger marine species because they feed on prey buried below the seafloor, stirred up by their snout, and were therefore exposed to extremely high concentrations of toxins. Although sawfish have now stopped dying, it will take at least a year before Grubbs knows how devastating the event has been. With a likely adult population of below 1000 before the disaster, he fears it could be a "significant" blow to the species.

Such algal blooms are becoming more common around the world. Between 2003 and 2020, they increased their cover by 13.2 per cent and increased in frequency by almost 60 per cent, according to one study. Not all blooms are toxic. But they can still be a warning sign of an ecosystem under stress.

> "Things are so bad, scientists have described the Atlantic as 'running a fever'"

"There's definitely change afoot," says Andrew Turner at the UK's Centre for Environment, Fisheries and Aquaculture Science. "We are seeing the emergence of harmful algae in certain areas where it has never been seen before."

In June 2023, a bloom of benign *Noctiluca* phytoplankton in the North Sea turned waters a scummy orange: the slick was so large it could be seen from space. This part of the North Atlantic has suffered some of the most extreme heat in the previous 18 months, with temperatures up to 5°C above normal in June this year. Things are so bad, NOAA scientists have described the Atlantic as ›

RAY COLLINS

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"running a fever". And colourful blooms aren't the only symptom.

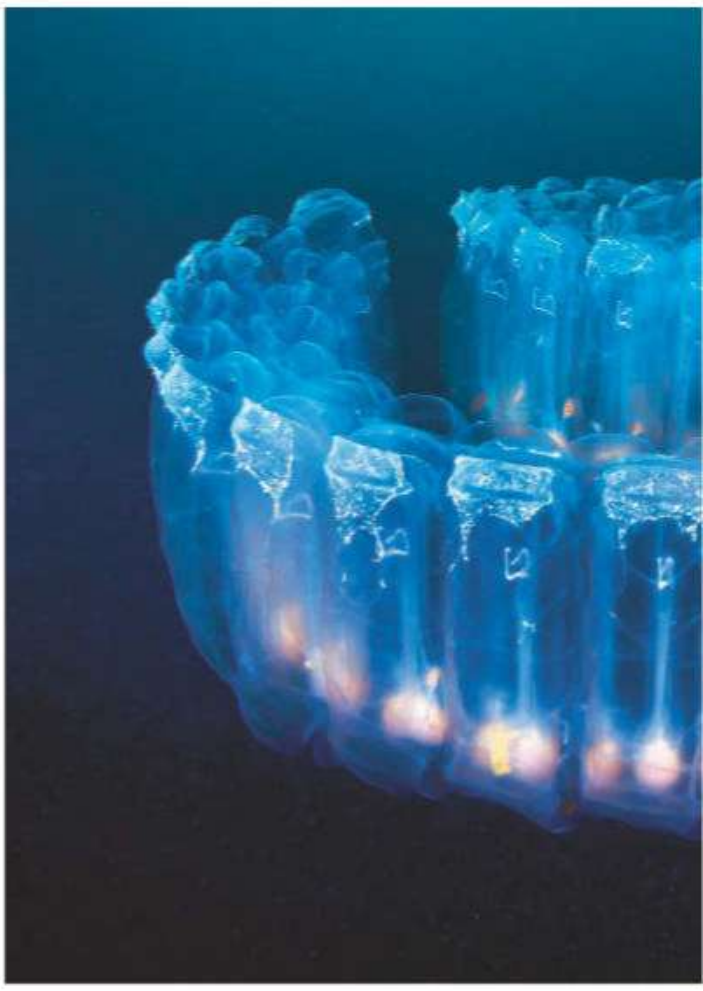
Ocean waters are naturally stratified into layers, with warmer, fresher, oxygen-rich water near the surface and cool, salty, nutrient-dense water further down. As the oceans heat up, there is less mixing between these layers, preventing nutrients from travelling to the surface and oxygen from sinking to the deep ocean. As well as setting the stage for algal blooms, this causes problems for phytoplankton, tiny, plant-like organisms that turn sunlight and carbon dioxide into sugars and oxygen. Increased stratification "prevents nutrients from coming up into the surface layer, where the phytoplankton need them," says Angus Atkinson at Plymouth Marine Laboratory, UK. As a result, phytoplankton numbers in the English Channel during the northern hemisphere summer have halved over the past 35 years, he says.

The extreme ocean heat of 2023 may have turbocharged the problem. A 2024 preprint paper indicates that the production rate of phytoplankton, algae and bacteria slumped by 22 per cent globally in April 2023, when global sea surface temperatures were at record highs. The drop in production was particularly pronounced in the North Atlantic. Not only are there fewer phytoplankton, but the ones that are there are smaller. "That's double trouble if you're a grazer, because these tiny cells are too small for the traditional crustacean zooplankton to eat," says Atkinson. This has a knock-on effect for commercially important fish such as mackerel, cod and herring, which feed on crustacean zooplankton. Meanwhile, jelly-like creatures such as salps thrive on smaller plankton. Last year saw a surge in them along the UK's south-west coastline, highlighting the problem.

As ocean mixing declines, this could also cause havoc with the biological carbon pump, says Corinne Le Quéré at the University of East Anglia, UK. This is the process by which phytoplankton remove carbon dioxide from the atmosphere and ultimately transfer it as biomass from surface waters to the deep ocean. "This is a flux of carbon that is as big as the anthropogenic CO_2 emissions from human activities today," says Le Quéré. But researchers fear that if biomass particles can't sink as deeply into the ocean depths, the carbon they contain won't be locked away for as long. Changes to this nutrient mixing will have immediate consequences for marine ecosystems, says Le Quéré, and longer-term impacts on global heating – with huge implications for humanity.

Even in the coldest ocean waters, things aren't normal. In Antarctica, the past two years have been a "rollercoaster", says Ted Scambos at the University of Colorado Boulder. Until 2015, sea ice had been growing in extent each winter, but 2016 saw a sharp drop that largely stabilised until 2023, when another sharp drop saw sea ice coverage fall to a record-low maximum of 16.96 million square kilometres. Emerging data from the UK Met Office suggests 2024 will again be a near-record low year for sea ice extent in Antarctica.

Last year was "off the charts" for both low summer and winter sea ice, according to Scambos, with signs that warming waters



ALEXANDER SEMENOV/SCIENCE PHOTO LIBRARY/ALAMY

"Last year was 'off the charts' for both low summer and winter sea ice in Antarctica"

STEVE GSCHMEISSNER/SPL/ALAMY

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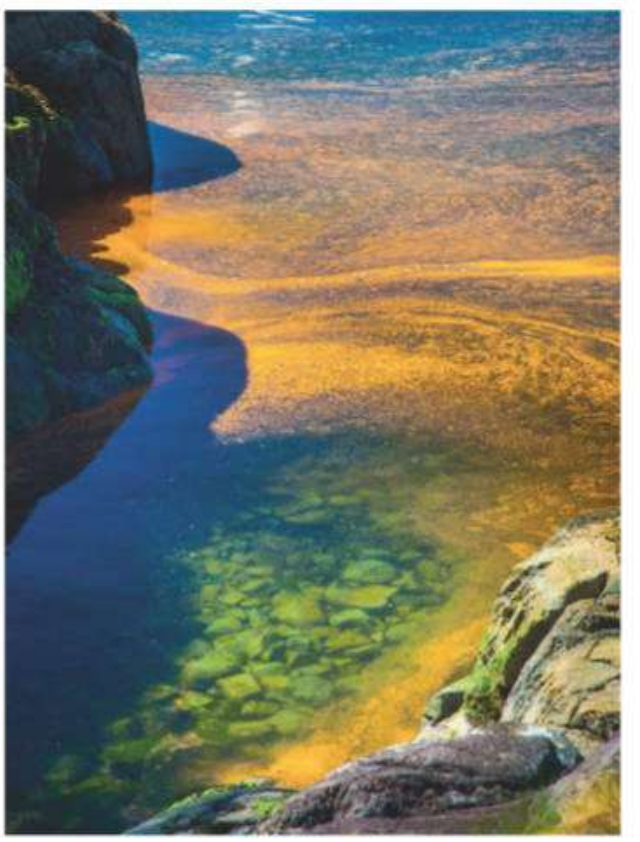
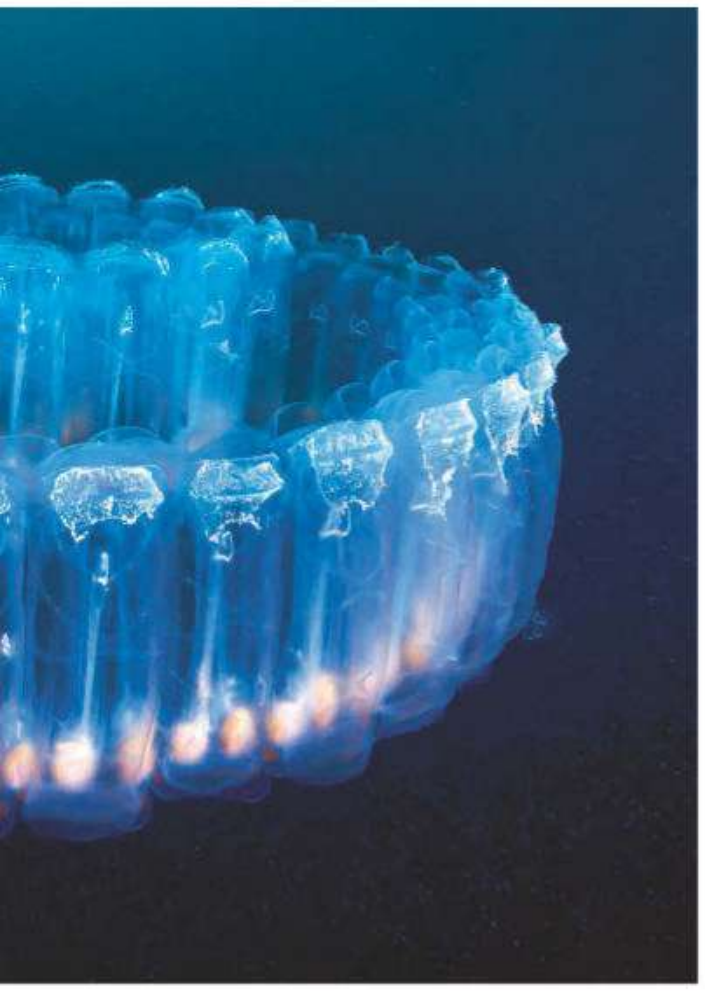


JULIAN NIEMAN/ALAMY

Phytoplankton numbers and Antarctic ice (top and bottom left) are in decline, while algal blooms are proliferating (above)



MAGNUS LARSSON/ALAMY

Ocean warming has caused swarms of gelatinous salps (left) and mass coral bleaching (below)

around Antarctica are to blame. "It appears that the uppermost ocean is holding more heat than it used to. So, as the sea ice starts to extend northward, it hits ocean that still has residual heat left in it," he says. This has sparked fears that the Antarctic is undergoing a "regime shift" that means sea ice may never recover to its previous levels.

Changing currents

It gets worse, though, because Antarctic "bottom water" is also disappearing. This cold, dense, oxygen-rich water cascades off the Antarctic continental shelf and sinks to great depths, driving a global network of ocean currents transporting oxygen into the deep Indian, Pacific and Atlantic Oceans. But increased meltwater and reduced sea ice formation means Antarctic waters are less salty, making it harder for them to sink. In the Weddell Sea, bottom water volume has shrunk by more than 20 per cent in the past 30 years. The result is a slowdown in Antarctic currents, with circulation down by almost a third since 1992, according to research published last year. "That's a big change to that ocean circulation," says co-author Matthew England at the University of New South Wales, Australia.

Slowing currents mean even less oxygen entering the deep ocean – with global implications for marine ecosystems. In summer 2021, another season of record-breaking heat, half of deep coastal waters from northern California to the Canadian border had oxygen levels so low they were harmful to marine life. Modelling shows that even if CO_2 emissions were stopped today, oceans would still lose more than 10 per cent of their pre-industrial oxygen content and life-sustaining deep ocean environments would decline by at least 25 per cent.

What's more, warmer surface waters hold less oxygen, which is already causing disruption. In the East China Sea, numbers of Bombay duck – a gelatinous fish with a gaping jaw – are booming as warming waters and nutrient pollution have depleted oxygen levels. Bombay ducks thrive in a low-oxygen environment and are outcompeting native fish as oxygen levels drop.

Warming ocean waters pose immediate danger for life on land, too. For one, hotter water takes up more space, which leads to sea level rise. In 2023, the global average sea level reached its highest point since satellite records began in 1993. Following the current trend, it could rise another 20 centimetres by 2050, increasing the frequency and severity of coastal floods.

As oceans get hotter, the risk of more powerful storms also increases. "If the sea surface temperature is now more than 1°C warmer over the North Atlantic, that means the air over the North Atlantic will also be warmer," says Kuhlbrodt. For every degree Celsius that the atmosphere is warmer, it can hold 7 per cent more water vapour. "This means there's a higher likelihood for extreme precipitation events and higher likelihood for particularly strong storms," he says.

In July, Hurricane Beryl hit the Caribbean, the Gulf of Mexico and the US, causing widespread devastation and killing dozens. Beryl was the earliest Category 5 hurricane ever to develop and formed rapidly, strengthening from a tropical storm to a major hurricane in less than a day. Exceptionally high sea surface temperatures were a key factor in Beryl's power and explain why the storm developed so early in the season. Usually, more powerful storms come later, after the Atlantic has warmed up over the summer months.

How worried should we be about this ocean chaos? Very, says Johnson. "This is probably the biggest crisis that humanity is facing." Le Quéré feels similarly, warning that we are taking "big risks" by pushing ocean ecosystems into crisis. It is a sentiment shared by most oceanographers, who fear that we tend to forget just how much humanity depends on the oceans.

But there are things we can do to reduce the stress on them. These include limiting fishing, chemical pollution and other harmful human activities. Better conservation efforts would benefit fragile marine populations, such as Florida's sawfish. More information will help us understand what is happening in the oceans. For example, researchers at Plymouth Marine Laboratory have just deployed a new system to monitor plankton hourly, providing greater insight into how the plankton mix is changing in response to global heating. And detailed data collection, backed by artificial intelligence, promises more accurate forecasting techniques for everything from algal blooms to hurricanes, not to mention more sophisticated climate models. But oceanographers agree that immediate, rapid cuts to greenhouse gas emissions are the only real way to avoid catastrophe over the long term.

The El Niño weather pattern officially ended in June, and an expected return of La Niña conditions later this year may bring some cooling relief to the world's oceans. However, although global sea surface temperatures seem to be slowly subsiding, they are still well above the long-term average. Scientists are watching closely: if temperatures remain high, it could be a sign that global heating has entered a new phase of acceleration. ▮

Madeleine Cuff is an environment reporter for *New Scientist*

‘We have come to glamorise cynicism in our culture and it is hurting us in every way’

Being cynical damages our health and harms the economy. Psychologist **Jamil Zaki** tells Alison Flood how to become a hopeful sceptic instead

ACCORDING to Thomas Hobbes, one of history’s most famous cynics, life is “nasty, brutish, and short”. But according to Jamil Zaki, director of the Stanford Social Neuroscience Laboratory in California, this is, ironically, more likely to be true if you have a cynical, Hobbesian outlook on life, seeing the worst in humanity and failing to trust anyone.

Zaki didn’t always think this way. He has studied and lectured on the brain circuitry behind empathy and kindness for two decades, all the while harbouring a dirty secret: he was a cynic. It was after the death of his friend Emile Bruneau, who studied the neuroscience of peace and conflict and was “one of the most hopeful people I ever met”, says Zaki, that he began to examine his cynical perspective. He discovered that cynicism is not only harmful to our lives, but also makes us believe things that aren’t true. Luckily, there are tools we can use to combat our cynicism, as he explores in his upcoming book *Hope for Cynics: The surprising science of human goodness*.

PAUL RYDING

Alison Flood: What is cynicism?

Jamil Zaki: Cynicism is a theory that, in general, humanity is selfish, greedy and dishonest. Theories power our behaviour, what we do and what we don’t do. So cynics use their theory about people to guide their behaviour in the social world. It changes what they see, it changes how they interpret other people and it changes what they do, such as not trusting others.

How does cynicism differ from scepticism?

That’s really important. Cynicism and scepticism are often confused with one another, but they’re really quite different. I think of cynics as like lawyers in the prosecution against humanity. They have negative assumptions about people, and they seek out evidence about all the harm and terrible things that people do, ignoring evidence about their positivity. Scepticism [involves] openness to information about the world and about people in general. Sceptics think more like scientists.

What makes a person a cynic?

Cynicism is heritable, meaning that if your parents are cynical, there’s a higher chance that you will be as well. But a lot of cynicism has to do with our experiences of life, in particular our early experiences. Cynics act as though they’re very confident, in a sneering way, about the world. But actually, research suggests a lot of them have been hurt in the past. So I think that betrayals and other forms of trauma can lead to cynicism. I completely understand why and I don’t want to seem like I’m attacking cynics. I have been a cynic myself and I know that it’s really hard when you’ve been hurt to trust others again. And yet the case I’d like to make is that even for those of us who have ›

DIS
TRUST

been hurt, cynicism hurts us again by closing us off to opportunities for new relationships, new experiences. Cynicism makes it harder for us to learn, and thus causes us to miss all sorts of opportunities.

Are we becoming more like this?
People have become more cynical, and younger people are less trusting than older adults. A survey from 2014 found that only 18 per cent of 12th graders [17 to 18-year-olds] in the US believed that most people can be trusted. That was lower than the general level for adults at the time, which was around 30 per cent. But that's all worse than it was about 50 years ago, when about half of adults in the US thought most people can be trusted. These percentages are from the General Social Survey, which has surveyed tens of thousands of Americans over the years.

Why has this happened?
There are so many reasons that cynicism is on the rise. Some of them are structural – increased inequality, the way that we use media, such as news outlets focusing on negative stories to grab our attention. All of these things can increase our cynicism. But we have also come to glamorise cynicism in our culture. We act as though cynics are smart. If you ask people to choose either a cynic or a non-cynic for difficult intellectual tasks, most people will think that a cynic will outperform a non-cynic. And about 85 per cent of people think that cynics will be better lie detectors than non-cynics. We think they're not just smart, but socially smart.

But over the course of several years now, researchers have looked at cognitive performance in hundreds of thousands of people and found that cynics perform less well on analytical tasks, on mathematical tasks and on social tasks, like figuring out who is telling the truth and who is lying.

So we have an absolutely backwards idea about cynicism that might be encouraging us to act cynically in order to impress the people around us, even though we're actually acting in a way that's less accurate and less helpful.

Can being too cynical hurt us in other ways?
Cynicism hurts us in basically every way a scientist can measure. Cynics suffer in terms of their mental health. They are more depressed and anxious. They tend to abuse substances like alcohol more; their relationships are shorter-lived and less satisfying. Their health is worse – everything from cellular inflammation to coronary disease to diabetes, all these are predicted by cynicism. They do worse financially. If cynicism was a pill, it would be a poison.

Tell us about the evidence behind this.
Ever since the 1950s, psychologists have measured people's cynicism using something known as Cook and Medley's cynical hostilities scale. You tell researchers whether you agree with a set of statements. For instance, "most people are only nice in order to get something from you", or "people only act honestly because they are scared of being caught". If you believe these things about human nature, that clocks you in the eyes of researchers as a cynic, and for decades, researchers have gathered information about people's cynicism and correlated it with their life outcomes.

But doesn't cynicism also correlate with hardship in life? Can the relationship between cynicism and poor outcomes be explained by this?
None of the studies I've mentioned make people into cynics and then measure how their lives unfold. Cynicism correlates with hardship and we can't completely rule out the impact of that on the outcomes. But the relationship between cynicism and poor outcomes also can't be explained away by people's race, gender or income.

> "Cynicism is like a tourniquet that cuts you off from social connections"

Cynical communities tend to do worse than those with strong networks of relationships

MARC ASENSIO/NURPHOTO VIA GETTY IMAGES

Cynicism alone might not ruin our lives, but it doesn't sweeten them, either.

Why are cynics so much worse off?
We are fundamentally social creatures. We flourish through our connections with other people. Cynicism is like a tourniquet that cuts you off from those connections and makes it impossible to receive the psychological nourishment that we all need. That connection decreases our stress, decreases our cellular inflammation, improves our immune function, improves our sleep, improves our mental health.

Presumably this has wider implications too?
People require relationships to be healthy, and communities require a network of relationships to flourish. So communities that are cynical versus less cynical tend to do a lot worse. Their happiness is lower, and they're less likely to bounce back from difficult times, and they're also less likely to grow financially. Researchers at one point looked at the relative trust of dozens of nations, and then for years afterwards, looked at the growth in their GDP. They found that trusting nations, controlling for all sorts of other factors, grew economically, whereas more cynical nations flatlined or cratered economically.

Would you describe yourself as a reformed cynic?
I'm not reformed. I'm in recovery. I still struggle with cynicism, as I think most people on the planet do.

How can we fight our internal cynic?
To live an anti-cynical life requires three steps,

ANDREW CABALLERO-REYNOLDS/AFP VIA GETTY IMAGES

In the US, Republican and Democrat beliefs overlap more than many people expect

none of which always come naturally. It's like cynicism is a treadmill pulling us in one direction towards a bleak view of each other, so we have to be active in combating it. That means thinking differently, acting differently and sharing differently.

Thinking differently requires adopting a mindset I call hopeful scepticism. So be sceptical – open to information about people instead of relying on our assumptions – and also understand our bias towards the negative and actively counteract it. So when you start thinking about somebody, when you start telling a story about somebody, think about something positive that you can use to describe that person. Start the conversation there. It's not putting on a pair of rose-coloured glasses. It's taking off the mud-coloured glasses that most of us are usually wearing.

The second is to act differently. This means doing things that show people that we're not being cynical towards them, taking calculated leaps of faith on them.

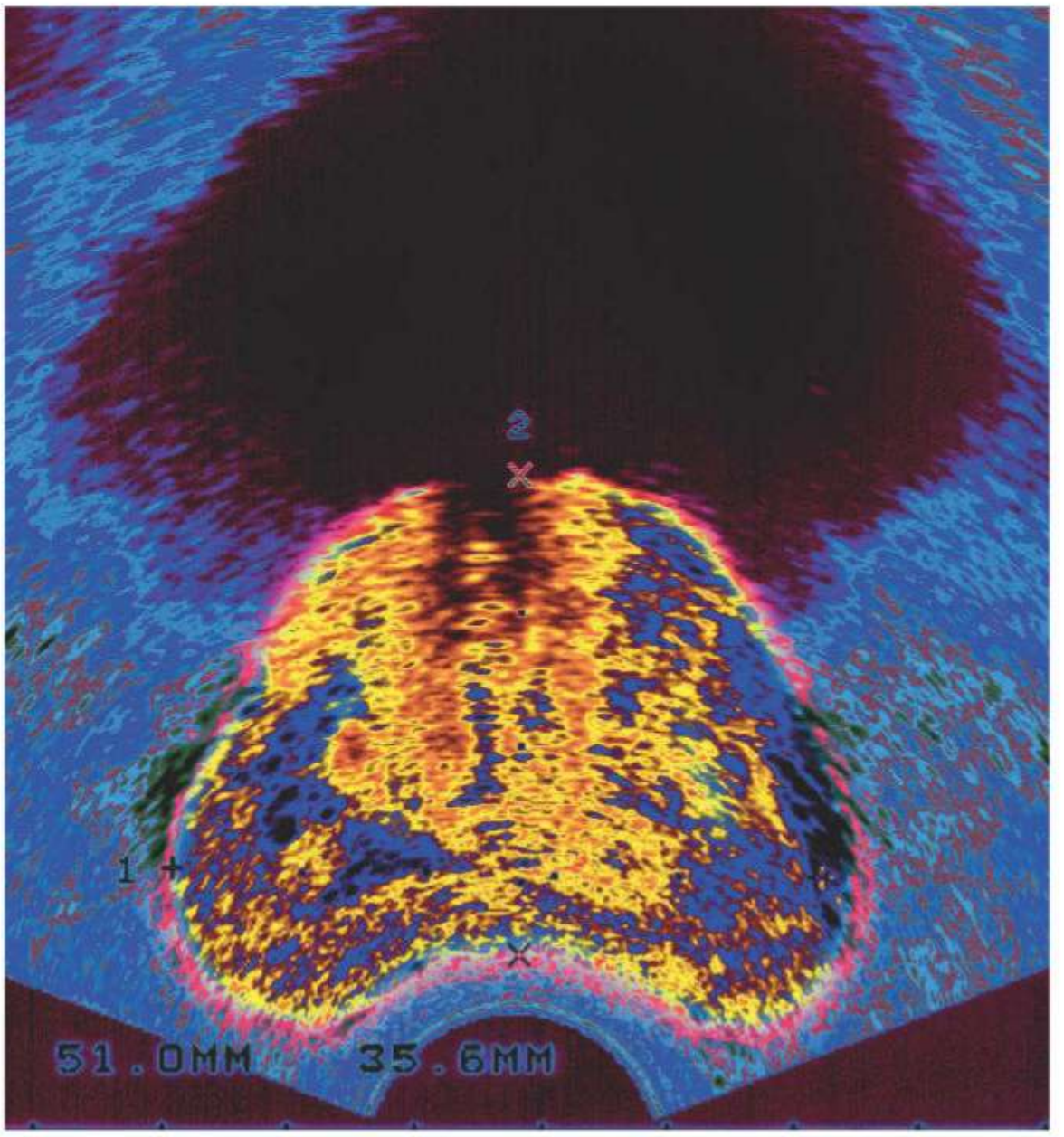
The third is to share differently, and this is, in essence, being able to understand our impact on others, not just fighting our own cynicism, but fighting it in the people around us. We're prone to not just being negative in what we think, but in what we say, talking about people who do harmful things, for instance, much more than we talk about people who do helpful things. So reorienting what we share with other people.

There is a fascinating study mentioned in your book about tribal cynicism, a belief that people on the "other side" are stupid or evil. Tell me more.
We are cynical about humanity in general, but we're even more cynical about people we disagree with. And disagreements get worse because we're completely wrong about who's on the other side. We think that people we disagree with are much more extreme, much more hateful and much more violent than they really are. In one study, researchers asked Republicans and Democrats in the US how open or closed they wanted our southern border to be, and they also asked them "what do you think the other side believes?". The data showed that Republicans want more of a closed border; Democrats more of an open border. But there was a lot of overlap. Really, both groups were pretty close to the middle. But if you ask them what the other group thinks, they believe that the other side was totally extreme. In other words, there's a whole bunch of common ground that we obscure through our cynical beliefs about the people we disagree with.

> "When we feel cynical about climate change, we're less likely to do anything."

Do you think that hopeful scepticism is enough to deal with the major problems of our time?
Absolutely not. But I can tell you this: cynicism is not a radical feeling, it's a tool of the status quo. When we feel cynical about major problems like climate change, we're less likely to do anything about it because we feel that our actions have no meaning. Hope is not the same as optimism. It's not the belief that things will automatically get better. It's the belief that they can get better and a sense of empowerment, a sense that we can have something to do with that improvement. So hopeful scepticism is part of a solution. I think it's the beginning because it inspires action. ▮

Alison Flood is *New Scientist*'s comment and culture editor



CAVALLINI JAMES/BSIP/ALAMY

An ultrasound scan showing a prostate with signs of cancer

The prostate time bomb

Deaths from prostate cancer are projected to dramatically surge over the next 15 years. Thankfully, we are getting to grips with how to diagnose this life-threatening condition, finds **Graham Lawton**

AS A man in my mid-50s, I am starting to think about what might be coming to haunt me in later life. One persistent worry is prostate cancer. I have a family history of it, which puts me at higher risk. I don't have any major symptoms. Still, I should probably have gone for a test by now. But for years I have read that they aren't very accurate and can lead to unnecessary surgeries that carry a risk of incontinence and impotence. And people keep telling me that even if you have prostate cancer, you are unlikely to die of it.

I am not the first person to be confused about prostate cancer and whether to test for it, but today these questions are of increasing importance because we are in the midst of a troubling global trend. According to recent projections, cases of prostate cancer are set to shoot up over the next 15 years, and if nothing is done, deaths will rise substantially too.

However, while the increase in cases is a foregone conclusion – a reflection of our ageing population – the increase in deaths isn't. That is because, in recent years, we have begun to see a transformation in our diagnostic tools. These are helping doctors to identify the most severe prostate cancers earlier and more accurately than ever before, helping people like me make more informed choices about our options and increasing the likelihood that we won't die of the condition. So, what exactly has happened, and what tests – if any – should I be signing up for?

To understand why prostate cancer diagnosis has ended up being such a minefield, it helps to understand a bit about the prostate itself. This small, chestnut-shaped gland is situated beneath the bladder. Its role is to produce fluid that, along with secretions from other glands, mixes with sperm cells to form semen.

The prostate doubles in size during puberty and enters a second growth phase around the age of 25, which continues indefinitely, eventually leading to an enlarged but non-cancerous gland, a condition called benign prostatic hyperplasia. "All men get it as they get older," says prostate specialist Nick James at the Institute of Cancer Research in London. About half of men aged between 51 and 60 have benign prostatic hyperplasia (BPH), according to the US National Institute of Diabetes and Digestive and Kidney Diseases. At age 80, the figure is 90 per cent.

Cancer is a different matter. "The two are separate processes," says James. Tumours arise in the lining of the gland's internal cavity and can start at any age, though they become more common as people get older. The trajectory from there is variable, ranging from slow-growing and essentially harmless cancers, which are called "indolent", to highly aggressive and lethal ones.

The majority of prostate cancers fall towards the indolent end of the spectrum, which has given rise to the truism that "more men die with prostate cancer than die of it". Around 1 in 8 people with a prostate will be diagnosed with prostate cancer in their lifetime, but vastly more go undiagnosed. Around 80 to 90 per cent of men aged 80 or over who die of something else turn out to have indolent prostate cancer, says James.

But that doesn't detract from the fact that the condition is extremely dangerous. Roughly 1.4 million people are diagnosed with prostate cancer every year, and a quarter of them will die from it. Those already-scary statistics are set to get much worse. Last year, the editors of *The Lancet* convened a special commission on prostate cancer to discover, among other things, what the future holds. In April, they published their findings, predicting that between 2020 and 2040, cases will more than double, to around 2.9 million a year, and deaths will rise by 85 per cent to 700,000.

The projections shocked even seasoned prostate cancer experts. "We didn't know," says James, who chaired the commission. "I was genuinely quite surprised."

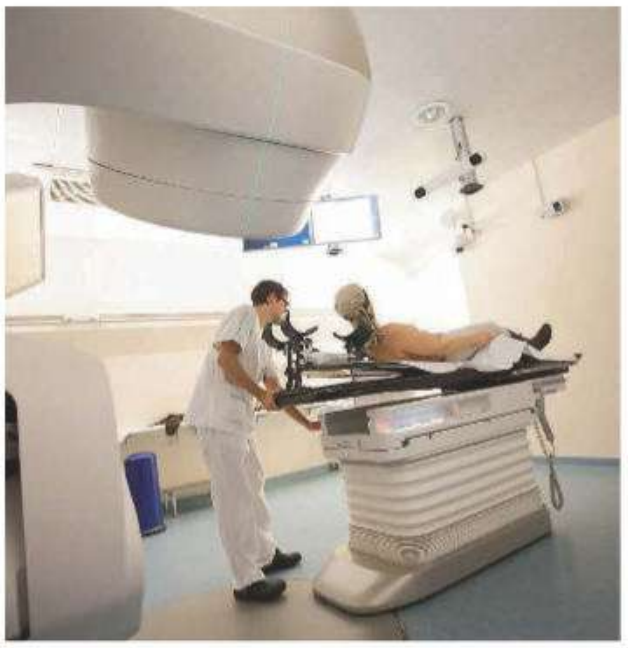
The lion's share of cases and deaths will be in low and middle-income countries. But nowhere is immune. Western Europe, for example, is projected to see a roughly 25 per cent increase in cases and 20 per cent increase in deaths. North America will see deaths rise by a third.

Booming burden

The predicted surge is down to an expanding and ageing global population. And, according to *The Lancet*'s commission, almost nothing can be done to avert the rising number of cases. Unlike many other cancers, the risk of prostate cancer can't be significantly reduced by lifestyle changes or public health interventions. This makes the increase in the condition a different challenge from the inevitable rise in cancer overall as populations age. As the commission concluded, "dealing with this rise in cases will require urgent and radical interventions".

So, what can be done? Prevention may not be an option, but curing it is. Early-stage prostate cancer, where the tumour is confined to the gland itself, is eminently curable using ›

> "1.4 million people are diagnosed with prostate cancer every year



AMELIE-BENOIST/BSIP/ALAMY

A patient awaits radiotherapy for prostate cancer

> “This cancer is eminently curable using surgery or radiotherapy if caught early

surgery and radiotherapy. “The treatments, by and large, work very well,” says James. Fifteen years after diagnosis, only around 3 per cent of people who have treatment for early-stage prostate cancer will have died from it in most high-income countries. However, once the cancer has spread, or metastasised, and invaded the bones, liver or lungs, it is nigh-on incurable. “Almost everybody who presents with metastatic disease dies of it,” says James. The key, therefore, is to catch it early.

Easier said than done. Prostate cancer symptoms, such as reduced urinary flow, don’t usually manifest until late in the game. “Symptoms are a very poor guide,” says James. “Cancers tend to be in the peripheral part of the gland, so they have to be really very big before they’re starting to impact urine output.”

The solution to that is screening, where anyone of a certain age – most commonly 45 to 50 – who has a prostate is routinely tested. But historically this has been extremely hit-and-miss. Prior to the mid-1990s, the best-available detection method was a rectal exam, where a doctor felt the prostate with a gloved finger. There was, however, scant evidence that this led to the discovery of a significant number of cancers or decreased mortality rates.

Then came the PSA revolution. In 1979, researchers at the Roswell Park Cancer Institute in Buffalo, New York, purified a protein from seminal fluid that they called prostate-specific antigen. PSA was often elevated in those with prostate cancer and the team proposed that it could be exploited for diagnosis. In 1994, the US Food and Drug Administration approved a PSA test to aid the detection of prostate cancer in men over 50.

For a while, PSA testing seemed to have changed the game. According to William Catalona at Northwestern University in Chicago, Illinois, the widespread uptake of PSA testing in the US led to a much higher rate of early detection, with the number of diagnoses of late-stage cancer falling by 80 per cent.

But screening doesn’t detect all cases of prostate cancer. “Sometimes the very worst cancers make very little PSA, so that is a problem with the test,” says James. And that’s not all. “Screening was associated with substantial harms,” says Jeffrey Tosoian at Vanderbilt University Medical Center in Nashville, Tennessee. The tests produce a lot of false positives, for example, mainly because having an enlarged but benign prostate raises PSA levels, says James. They also detect indolent cancers that would never have caused symptoms, let alone death.

When PSA tests were first rolled out, an elevated score automatically triggered the next step, a biopsy. Under this protocol, says Tosoian, 1 in 5 people who were screened ended up having a biopsy – 75 per cent of these were negative and the majority of the positives were clinically insignificant indolent cancers. That adds up to a lot of needless anxiety. Plus, the biopsies can lead to infections, urinary and faecal incontinence and impotence. This overdiagnosis and overtreatment meant that around a decade ago, PSA testing was widely deemed to be doing more harm than good, leaving people like me in a state of confusion.

In 2012, an influential expert panel in the US called the Preventive Services Task Force performed a volte-face and advised against PSA testing. The UK, which had been considering implementing a routine prostate cancer-screening programme, canned it. The EU took a similar anti-screening stance.

There is also mixed evidence on whether screening meaningfully decreases the risk of death from prostate cancer. One large trial in the UK, for example, which offered men aged 50 to 69 a one-off PSA test, found that 10 years later, there was no reduction in prostate cancer mortality between those who took the test and those who didn’t. A further follow-up of the participants at the 15-year mark did find a reduction in mortality among those who had been tested, but it was vanishingly small. A similar trial in Stockholm, Sweden, found no reduction in prostate cancer mortality 20 years after a one-off PSA test.

Test, test and test again

Since then, however, the diagnostic landscape has begun to change, making the path forwards a lot clearer. First, it was discovered that while one-off PSA testing may not reduce mortality, repeated testing does. In 1994, Maria Frånlund at the University of Gothenburg in Sweden and her colleagues recruited 20,000 men aged between 50 and 65 who were either given PSA testing every two years or were part of a control group that only received opportunistic PSA tests, which are when a person decides to request the test for themselves. When the researchers analysed the data after 22 years, they found that men who had been repeatedly tested were around half as likely to have died

SOLSTOCK/GETTY IMAGES

from prostate cancer as those in the control group. "Prostate specific antigen-based screening substantially decreases prostate cancer mortality," they concluded.

Helpfully, PSA testing itself has also improved significantly, minimising the dangers of overdiagnosis and overtreatment. Instead of going straight to a biopsy, a high PSA score now generally triggers an intermediate step: an MRI scan of the prostate gland to look for abnormalities. This reduces the number of biopsies and also allows for targeted biopsies of any suspicious areas, instead of a standard "systematic" one that takes samples from all over the gland. Another recent advance is active surveillance, where those who are diagnosed with benign-looking cancers via PSA and MRI are spared the biopsy knife but are retested every year. Last year, a trial comparing this wait-and-see strategy with immediate treatment showed that the two are equally effective, says James.

In 2018, off the back of these improvements, the US Preventative Services Task Force changed its mind again, recommending that those aged 55 to 69 should be able to get a test if they want, as long as they discuss it with their doctor before proceeding. In 2022, the European Union also did a U-turn and urged member states to consider setting up routine screening programmes. In the UK, individuals are entitled to a PSA test but have to request one from their doctor and go through a round of counselling before taking it.

Today, we are seeing yet more changes that could transform our ability to catch prostate cancer early and accurately. For a start, the researchers behind the Gothenburg trial are currently testing which combination of PSA results and MRI is most effective. Then there is an ongoing clinical trial in Finland, which is testing whether adding another step between PSA and MRI improves diagnostic accuracy even further. That step is a blood test called a four-kallikrein panel, which looks at PSA in more detail and also detects kallikrein, another protein produced by the prostate gland that is often elevated in prostate cancer. An interim analysis of this data suggests the trial is having "great success" in its three main objectives, says Tosoian – to reduce the overdiagnosis of indolent cancers, reduce negative biopsies and detect the most dangerous cases.

Meanwhile, the charity Prostate Cancer UK launched a clinical trial called Transform earlier this year, which aims to find the best way to diagnose the condition without the pitfalls of overdiagnosis and overtreatment. It will test various combinations of PSA and MRI and will also include genetic testing to identify people at high risk of prostate cancer. Genetics will increasingly become part of prostate testing, says James, and may help minimise the other big downside of the PSA test: false negatives.

There are a handful of mutations that are known to significantly increase the risk of prostate cancer. A mutation in *BRCA2*, for example – one of the genes involved in breast and ovarian cancer – increases an individual's risk of prostate cancer by around 5.7 times. But mutations in about 200 other genes have been linked with the condition, and the more a person carries, the higher their risk.

Saliva screening

In May, a team from the Institute of Cancer Research and the Royal Marsden NHS Foundation Trust in London unveiled the results of an experimental saliva screening test that identifies mutations in 130 of these genes, from which an individual genetic risk score can be calculated. The researchers gave the test to 6000 men aged between 55 and 69 and invited those at the highest risk to come in for an MRI. Just under half of them turned out to have undiagnosed prostate cancer – and of the 187 cancers detected by this method, 103 were of high or intermediate risk.

Many of them would have received a negative PSA test. "A number of these men had significant prostate cancer, but with a normal PSA," says James, who was part of the team. "So it looks like this test may find at least some of those men with the very worst cancers but very little PSA, though this is very much a work in progress."

One final innovation is the use of artificial intelligence to interpret MRI scans. At present, this is done by human pathologists, but accuracy can be as low as 40 per cent. "Interpreting the pathology is something that AI can already do," says James. "And while pathologists can only look at a few scans, the AI can look at a thousand per patient. I think AI is going to be transformative."

All things considered, I have decided to get a PSA test regularly and will accept any MRI scans that are subsequently offered. I'll also happily take a genetic test if and when they become widely available. With the advances in testing, my chances of being overdiagnosed and overtreated are much reduced.

Whatever the outcome, thanks to our new diagnostic tools, hopefully I will grow old and become one of those men who dies with, rather than of, prostate cancer. ▮

After doubling in size during puberty, the prostate grows steadily later in life

> "New tests could transform our ability to accurately detect prostate cancer

Graham Lawton is a staff writer at *New Scientist*

The back pages

Puzzles
Try our crossword, quick quiz and logic puzzle p45

***Almost* the last word**
What would we see from the edge of the universe? p46

Tom Gauld for *New Scientist*
A cartoonist's take on the world p47

Feedback
Names and faces get the chicken-or-egg treatment p48

Twisteddoodles for *New Scientist*
Picturing the lighter side of life p48

Debunking gardening myths

Life in miniature

Is it worth including activated charcoal in your terrarium's potting mix? **James Wong** isn't convinced by this pricey product

James Wong is a botanist and science writer, with a particular interest in food crops, conservation and the environment. Trained at the Royal Botanic Gardens, Kew, in London, he shares his tiny flat with more than 500 houseplants. You can follow him on X and Instagram @botanygeek

Debunking gardening myths appears every month

Next week
Science of baking

TERRARIUMS have taken the horticultural world by storm over the past decade or so, going from obscure Victorian curiosity to a staple of homeware stores. Yet in almost any advice you will find on how to set up one of these miniature gardens in a sealed glass container – be it online, in books or through in-person courses – you will come across a tip to include activated charcoal in your potting mix.

This substance is more easily tracked down as a fancy food supplement. It can sell for pretty exorbitant prices and is often described as essential to creating a functioning terrarium. But is this really the case? Let's take a look at the evidence.

First off, it is plausible that this form of charcoal has measurable benefits as an addition to a potting mix. The tiny air pockets formed in its creation result in an enormous surface area, and with that an impressive ability to absorb compounds dissolved in water-based solutions.

For this reason, it is used in emergency rooms as an evidence-based treatment for poisoning and overdoses. It is thought it could also be useful in horticulture to hold water, air and nutrients, the three things plant roots need, and that it could even provide a habitat for beneficial soil microbes.

Trials to test this hypothesis have yielded compelling results in agricultural soils, but there is a lack of experimental data to support the claims of charcoal's apparent, very specific benefits in terrariums. Despite this, proponents claim it is essential to absorbing toxins and preventing fungus outbreaks that occur in the humid, sealed environment in these tiny glass vessels.

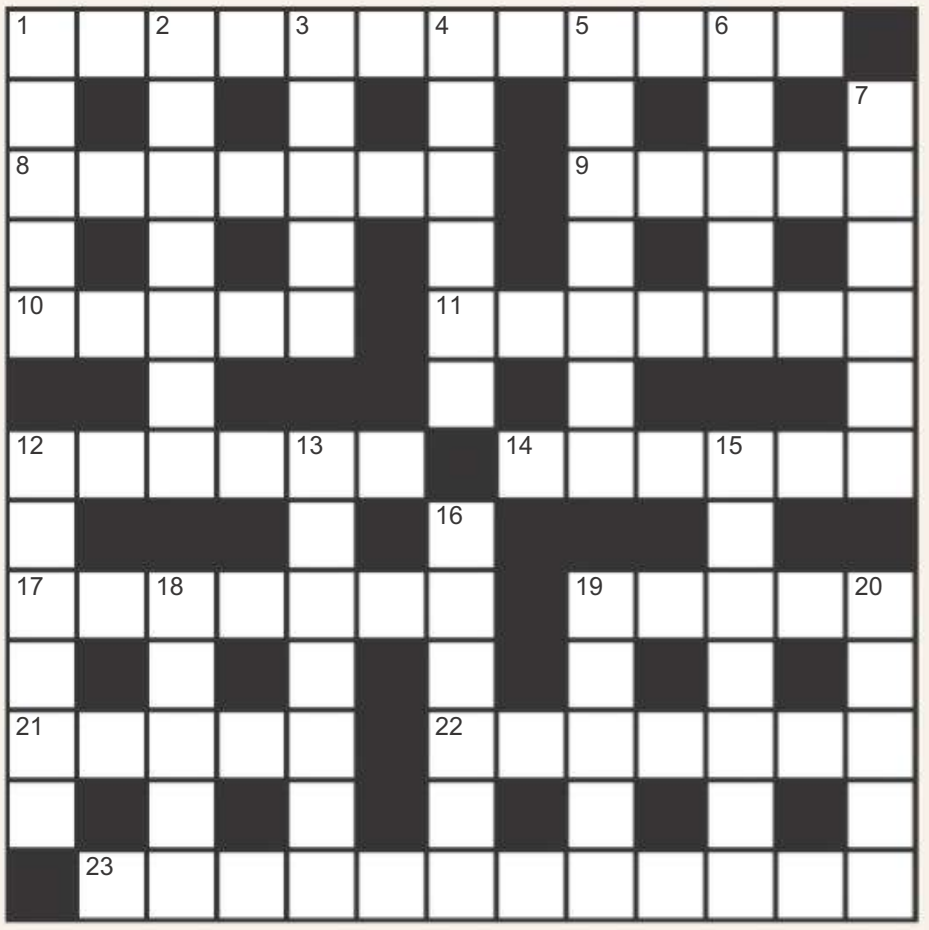
BARBARA BRONSON/ALAMY

But are these benefits worth the cost? With tiny tubs of the stuff often selling for eye-watering prices – gram for gram around five times that of semi-precious stones like rose quartz and tiger eyes from some suppliers – I would expect to see benefits bordering on divine intervention to fork out this much. This is particularly the case when you consider that mould outbreaks and the build-up of toxins in terrariums are largely caused by the other main substrate the same people who recommend using charcoal often advise including: compost.

Compost is made up of partially rotted plant fibres, which, unsurprisingly, continue to decompose in the constantly warm, wet environments of these tiny greenhouses, resulting in unbalanced ecosystems that inhibit plant growth. Simply swapping your potting mix for a mineral-based alternative such as ground pumice or aerated clay pellets, which hold air, water and nutrients just as well as compost but without rotting over time, will remove the need for charcoal and solve the most common terrarium issues – all at a fraction of the cost. No second mortgage needed. ▮

These articles are posted each week at newscientist.com/maker

Cryptic crossword #142 *Set by Rasa*



Scribble zone

Answers and the next quick crossword next week

ACROSS

1 Kitty sitting on moray trapper's paring tool (6,6)
8 Program involves Greek airport terminal (7)
9 Gas essentially flooded area (5)
10 Dig passage from rondel verse (5)
11 At first, the shellfish glitter (7)
12 Most withdrawing quiet agreement ahead of time (6)
14 Hardware exhibit ditches Hawaii after end of March (3,3)
17 Appendage for sensing essence of orange, common base, and sodium (7)
19 Small, unfortunate animal's trail (5)
21 Finish half of meal, swallowing sound of disgust (3,2)
22 Flatten out petal crafted with gold (7)
23 Ancient librarian then admitted to ordering tea roses (12)

DOWN

1 Auditioner's stick set the tempo (5)
2 Friend supports child completely (7)
3 Overused device finally lost part of a pulley system (5)
4 Extremely pricey to maintain extended lots (6)
5 One bite destroyed hard rubber (7)
6 Almost decline old approved reading material (5)
7 Again mailed object to... (6)
12 ...barely populated rows at east end of village (6)
13 Unstops rum for stellar event (7)
15 Voice displeasure over thin kind of logic (7)
16 Plan hikes on Dad's grasslands (6)
18 For example, tug tall structure (5)
19 Discussed rod bacteria (5)
20 Licks grooves around doughnut (5)

Our crosswords are now solvable online
newscientist.com/crosswords

Quick quiz #265
set by Bethan Ackerley

1 In what year was the first Solvay Conference on Biology held?

2 Weywot is a moon of which dwarf planet?

3 The mathematician Fibonacci hailed from which republic?

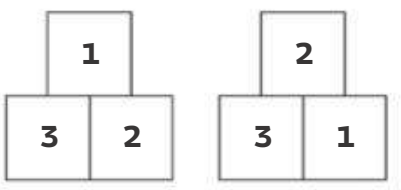
4 What is the pollen-bearing part of a plant's stamen called?

5 What was the first genus of non-avian dinosaur to be validly named?

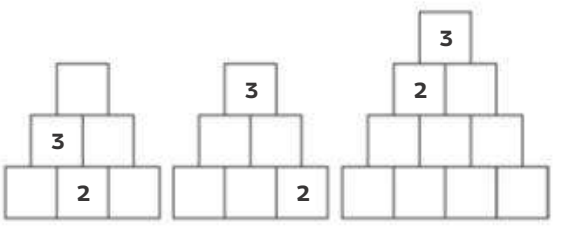
Answers on page 47

BrainTwister
set by Peter Rowlett
#33 Number triangles

There are two ways (shown below) to arrange the numbers 1 to 3 in a triangular grid so the number at the top of the triangle is the (positive) difference between the two making up the base. (We can mirror each arrangement right-to-left, but won't count these mirror images as different.)



Can you complete these grids (below), where each triangular grouping of three squares follows the same rule? The first two triangles use the numbers 1 to 6 and the third uses the numbers 1 to 10.



There are four ways to fill a triangle with the numbers 1 to 10. Two have a 3 at the top and two have a 4 at the top. One of these has been started in the example above – can you find the other three?

Solution next week

On the edge

If we could take a giant step to the furthest point of the universe and look out, what would we see?

Herman D'Hondt
Sydney, Australia
The simplest answer is that nobody knows.

Right now we can see to a distance of about 46 billion light years, the edge of the so-called visible universe. However, most scientists will agree that, if we went there, the universe would look pretty much the same as it does from here.

Just how far the universe really stretches isn't known, but there is agreement that it is larger than what we can observe. As for jumping that far away, it needs to be realised that points at that distance, while still visible, are moving away from us at speeds greater than light. In other words, we would need magic to get there.

There may not even be a "furthest point", as it is possible the universe is positively curved, which means it bends in on itself.

This is similar to the surface of Earth. No matter how far you travel, there is never any edge, you can always keep walking further.

"Our best evaluation suggests that the universe is flat, or possibly has negative curvature, and may stretch to infinity"

However, at least with our best measurements, it looks very likely the universe is flat, with a small chance it has a negative curvature. In both cases, the universe may literally stretch to infinity.

Then there are the various flavours of the multiverse, the idea that there may be additional universes beyond ours. There have even been suggestions that we may be able to spot points of contact with other universes by observing signatures of this in the cosmic microwave background radiation. That would mean we can see "outside" our universe without even moving to the "edge".

Dennis Doren
Lake Mills, Wisconsin, US
You would see nothing at all. If the concept of "furthest point" has any meaning, then that concept necessarily means there can be no light coming from "beyond", and hence literally nothing to see.

Eric Kvaalen
Les Essarts-le-Roi, France
There may not be a furthest point of the universe.

There is the furthest point that we can see, but that is simply the most distant location from which light has had time to travel to us (or a bit less far, because in the very early cosmos light couldn't propagate far due to absorption). If we were to go to that part of the cosmos and look beyond, I think we would see more of the same. But God only knows.

Mike Follows
Sutton Coldfield, West Midlands, UK
In detail, the universe would look different from what we see, but it is isotropic and homogeneous. This means, on a large scale, it looks the same in all directions and viewed this way at two random places in the universe, it would look indistinguishable.

The universe has no centre and no edge and it can be imagined like the surface of a Möbius strip, formed like a strip of paper with a 180 degree twist put in it before joining the ends. Tracing a course on this surface would have no beginning or end.

Bruce Cumming
Sydney, Australia
After taking that giant step, we would see a giant leg stretching back to where we stepped off from.

MARCO BOTTIGELLI/GETTY IMAGES

This week's new questions

Homeward bound **Why does the return journey always seem much shorter than the outward leg on a day trip?** ***Derek Long****, Cambridge, UK*

A different view **Do black holes look the same from any angle?** ***Johnny Cleveland****, Columbus, Indiana, US*

Why does coming home after a day trip always feel like a shorter journey than the outward leg?

Top to bottom

Why, generally speaking, do large military planes have wings on the top of the fuselage, but on large commercial planes they are on the bottom?

Eric Grandfield
Almondsbury, Gloucestershire, UK
Large military aircraft are usually designed to carry bulky cargo, so the fuselage needs to be as low to the ground as possible for quick and efficient loading, usually via the rear fuselage but sometimes via the front. From time to time, their operations need to be on rougher terrain, so undercarriages need to be as short as possible and attached to the fuselage. Top-mounted wings allow these.

In general, the most efficient way to mount engines is on the wings. This way, the weight of the aircraft is spread over the wing, enabling a lighter structure at the wing roots, where the wing and fuselage meet. For ease of maintenance, engines need to be under the wing. Military transport aircraft require a slower minimum airspeed to enable shorter take-off and landing. Hence, they are often powered by propeller engines, which offer this advantage, rather than jets. However, this requires engines higher from the ground – easier with top-mounted wings.

There are, however, some disadvantages to a high wing. A key one is that this design results in two areas of high load: the wing root and the undercarriage mountings. So where bulky cargo and the previously mentioned airfield performance needs aren't

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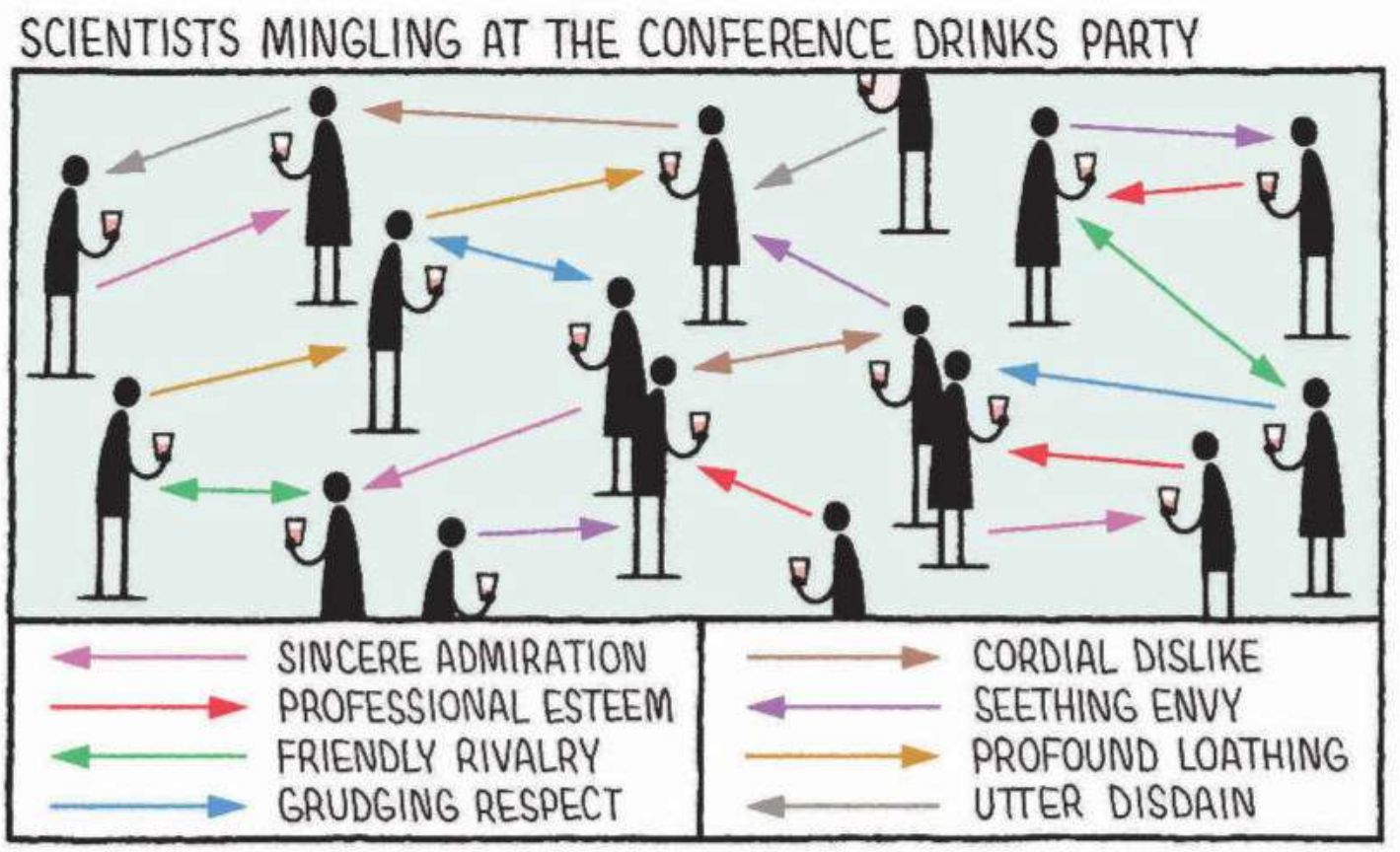
Tom Gauld
for New Scientist



present, we go for a low wing. As well as easier engine maintenance, the low wing gives more general maintenance advantages.

Chris Daniel
Glan Conwy, Conwy, UK
The most efficient wing position on an aircraft is at the base of the fuselage to minimise structural weight and maximise occupant safety and comfort. There must therefore be compelling reasons for military transport planes to depart from this design and have high wings instead.

One good reason is that these aircraft typically need to carry large loads such as vehicles and pallets, so it is desirable to have unobstructed floor space the length of the fuselage. This is achieved by mounting the strong and bulky wing attachment to the top of the fuselage.

A secondary benefit of this position is to reduce the risk of damage to the wings and engines from debris on the ground when the plane operates from rough or unprepared airstrips. The tactical advantage of good downward visibility is also possible in aircraft with this configuration.

"Low wings can provide buoyancy if a plane ditches in water, as seen when an airliner came down in the Hudson river in 2009"

The undercarriage on such planes has to be accommodated in pods on the lower fuselage, which add extra weight and aerodynamic drag to the aircraft, but these considerations aren't as important for large military planes as they are for civilian ones. The landing gear on some of these aircraft are designed to "kneel" to lower the fuselage, making loading easier and less dependent on ground facilities.

Civilian jet airliners, with a few exceptions, have low wings with the engines mounted below them and the undercarriage accommodated inside the wing structure.

In such cases, the obstruction created by putting the wing root in the lower part of the fuselage doesn't cause a serious problem, as access for loading baggage and other small cargo items can be gained from appropriately placed hatches in the side of the fuselage.

What's more, the floor of the passenger cabin is above the hold near the middle of the generally circular cross-section of the fuselage, which is where the width is greatest.

In addition, low-mounted wings and engines give a quieter ride for the passengers and make servicing and refuelling easier for the ground staff.

Civilian aircraft mostly operate from well-maintained airports where the risk of foreign object damage is low. And in the event of a wheels-up landing, passengers are protected to some extent by the engines and wings, which will absorb some of the impact.

When ditching in water, low wings can also provide buoyancy, as shown by the famous forced landing of an Airbus A320 in New York's Hudson river in 2009. ▮

Answers

Quick quiz #265 *Answers*

1 2024
2 Quaoar
3 The Republic of Pisa
4 The anther
5 Megalosaurus

Quick crossword #164 *Answers*

ACROSS 1 Hoopoe, **5** Micro-RNA, **9** Meniscus, **10** Astute, **11** Spiral galaxy, **13** Coil, **14** Ceramics, **17** Grey seal, **18** Lily, **20** Bloodletting, **23** String, **24** Omphalos, **25** Asbestos, **26** Entity

DOWN 2 Ogee, **3** Priestley, **4** Euclid, **5** Miscalculations, **6** Clangers, **7** Octal, **8** Not exactly, **12** Correlates, **15** Malignant, **16** Red light, **19** Simple, **21** Oxide, **22** Volt

#32 Crossed out of order *Solution*

The sequence 2, 3, 4, 1 is in middle-largest-smallest order if any number other than 1 is crossed out.

There are 10 ways to cross out two numbers from a sequence of five. You have five choices for the first number and four for the second, giving 20 options. But then you must divide by two to remove instances of the same numbers in reverse order.

One order for which more than half of the ways of crossing out work is 3, 4, 5, 2, 1. This is in middle-largest-smallest order after crossing out in these six ways: 3 4 X 2 X; 3 4 X X 1; 3 X 5 2 X; 3 X 5 X 1; X 4 5 2 X; X 4 5 X 1. Other orders that work are 3, 4, 5, 1, 2 and 2, 3, 4, 5, 1.

Face: the future

Should you take at face value a science paper that suggests that your face is the result of a "self-fulfilling prophecy process"?

A study called "Can names shape facial appearance?" claims it "probes the origins" of a supposed either/or question. The question: do parents choose a name that seems to match their infant's "innate facial characteristics" – or, instead, does the child's facial appearance, as they grow up, change shape to better match some stereotype of people who have that birth name?

Did Natalie always look like a Natalie? Or did her name impel her to become ever more Natalie-like? How about May? What of Dana, Jonathan, Daniel, Tom and Noam? The paper explores the facial fates of each of them.

The authors, whose first names are Yonat, Moses, Noa and Ruth, "suggest that even our facial appearance can be influenced by a social factor such as our name, confirming the potent impact of social expectations".

An eminent psychologist suggested to Feedback that, often, a startling psychology report turns out to be at one of two extremes. That sometimes what looks like a cigar is indeed a cigar. And that sometimes it is just smoke, just "one of those statistical things where despite significant differences they were all wrong most of the time".

Many years from now, will this names-and-faces study accord to whatever stereotype it now seems to fit? Or will its reputation grow to resemble some sharply different stereotype? Or, like most reports, scientific or otherwise, will it mature into being overlooked or forgotten? Time will tell. Or it won't.

Twisteddoodles *for New Scientist*

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Consideration of items sent in the post will be delayed

Whack-a-mammoth

People, some of them, take care in how they describe things.

The team who worked to tease out secrets from a 52,000-year-or-so-old hide of a mammoth (Feedback is trying to avoid the ambiguity that lurks in the phrase "mammoth hide") got a surprise (*New Scientist*, 20 July, p 17). They found that beating a dead horse, or cow or mammoth, might not be as destructive – on a molecular level – as one would guess.

Specifically, they found their frozen mammoth's genomic info had survived the presumed beatings of time. Further beatings were done to freeze-dried tissue from cows, not mammoths.

Horses, too, were involved – but only in bits and bytes, not in beatings. The team used segments of horse genome in computational aspects of their analysis.

The beatings took many forms. The paper documenting the affair calls them "perturbations". More long-windedly, it calls them "disturbances that ancient dehydrated samples might plausibly encounter through millennia".

This is how the paper describes those perturbing pummellings: "run over by a car, hit with a fastball, and pulverized with a shotgun, for varying degrees of mechanical impact; baking in a toaster oven for 1 h, microwaving for 6 min, dropping into liquid nitrogen, for thermal disturbance; and soaking, in either plain water or with added lemon juice".

In choosing words, there is potential not just to improve, but to go even further. PETA (People for the Ethical Treatment of Animals) published a "Complete List of Animal-Friendly Idioms". It recommends as a matter of taste to not say "beat a dead horse", and instead say "feed a fed horse".

A little bit random

Though you may not have heard anyone say "stochastic accuracy", chances are you can recognise it.

When you examine a bunch of reported "facts" and notice that many of them really are not facts, you are seeing stochastic accuracy. You are detecting the presence of randomness.

Stochastic accuracy can be subtle, tricky to see. Sometimes, it pops into clarity only with painstaking technical measurements. Sharana Kumar Shivanand at the Alan Turing Institute in London did that recently in a study about covariance estimation using h-statistics. "The objective of this paper", he writes with technical scrupulosity, "is to analyse and ensure that only the stochastic accuracy is less than epsilon squared, divided by two".

Sometimes, though, it leaps out at you. Feedback invites you to find a shiny example of an official pronouncement that displays stochastic accuracy. Send a link, or other non-random evidence, to feedback@newscientist.com.

A ghostly confession

A one-foot-in-the-graves-of-academe note arrived here, in response to the discussion about "holy ghostwriters".

These are senior department members who automatically get co-authorship credit for research done by people of lower status (Feedback, 22 June).

The note says: "I have been asked on two occasions by research students to add my name to the authorship of their papers because they felt that it would give them more credibility. I agreed. I did at least read the manuscripts and suggest changes.

"I wrote another paper with help on the methods section from the first author. A third person involved in the work asked to replace me as last author because it would help his/her career. My career was as good as over, so I agreed to be last-but-one."

The writer eschews sharing credit for that note, and goes a step further, saying: "If you use this, please keep me anonymous." ▮

Marc Abrahams

Events

NewScientist

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Instant Expert

Inside the conscious mind

Saturday 7 September, 10am - 5pm | Conway Hall, London

The conscious mind acts like a conductor, orchestrating a symphony of sensations, perceptions, thoughts, and memories to create the unified narrative of a person's life. It allows us to experience the world around us and have a sense of self. Perhaps the greatest challenge facing neuroscientists today is understanding how this all arises from a complex network of just a kilo or so of brain cells.

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Jenny Bosten
Senior Lecturer in Psychology, University of Sussex

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Throughout a career, every swimmer has their own lane to follow. In his lane, Michael Phelps became the most decorated Olympian in history, achieving 28 medals and some of the fastest times ever recorded. Now, a new champion has entered the pool. Léon Marchand has already conquered his first World Record and is carving his own path through the water towards his dreams at Paris 2024. An inspiration to the next generation. Just like the legend before him.

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